Project design document form
(Version 11.0)

BASIC INFORMATION	
Title of the project activity	Introduction of the recovery and combustion of methane in the existing sludge treatment system of the Wastewater Treatment Plant of Cañaveralejo EMCALI in Cali, Colombia
Scale of the project activity	☐ Large-scale ☒ Small-scale
Version number of the PDD	7
Completion date of the PDD	26/09/2019
Project participants	Empresas Municipales de Cali EMCALI EICE ESP ALLCOT AG
Host Party	Colombia
Applied methodologies and standardized baselines	Methane recovery in wastewater treatment AMS- III.H, Version 9.0
Sectoral scopes	Scope: 13 Waste Handling and disposal
Estimated amount of annual average GHG emission reductions	56,632 tCO_2e

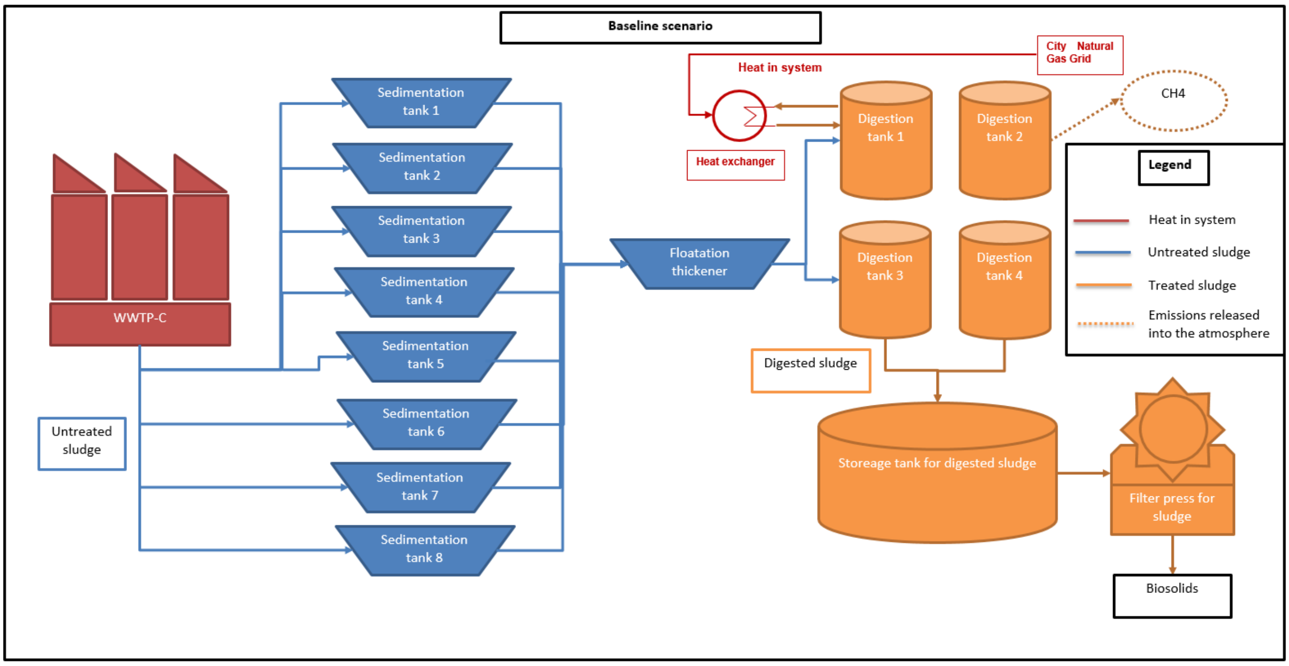
SECTION A. Description of project activity

A.1. Purpose and general description of project activity

The project activity qualifies as Type III: Other project activities not included in Type I or Type II that result in GHG emission reductions not exceeding 60 $KtCO_2e$ per year in any year of the crediting period.

During the primary treatment of the wastewater of Cali, carried out in the WWTP-C, sludge composed of the organic matter susceptible to the decomposition is generated. The sludge is produced in eight sedimentation tanks and next carried into thickener tank. Later on sludge is redirected to four covered anaerobic digestion tanks (digesters) with the purpose of obtaining more stable end-product and eliminating pathogenic microorganisms present in the untreated sludge (see Figure 1). The above mentioned anaerobic digestion, besides stabilizing sludge, generates biogas with high content of methane (between 57% and 64% according to the latest analyses undergone in WWTP-C1).

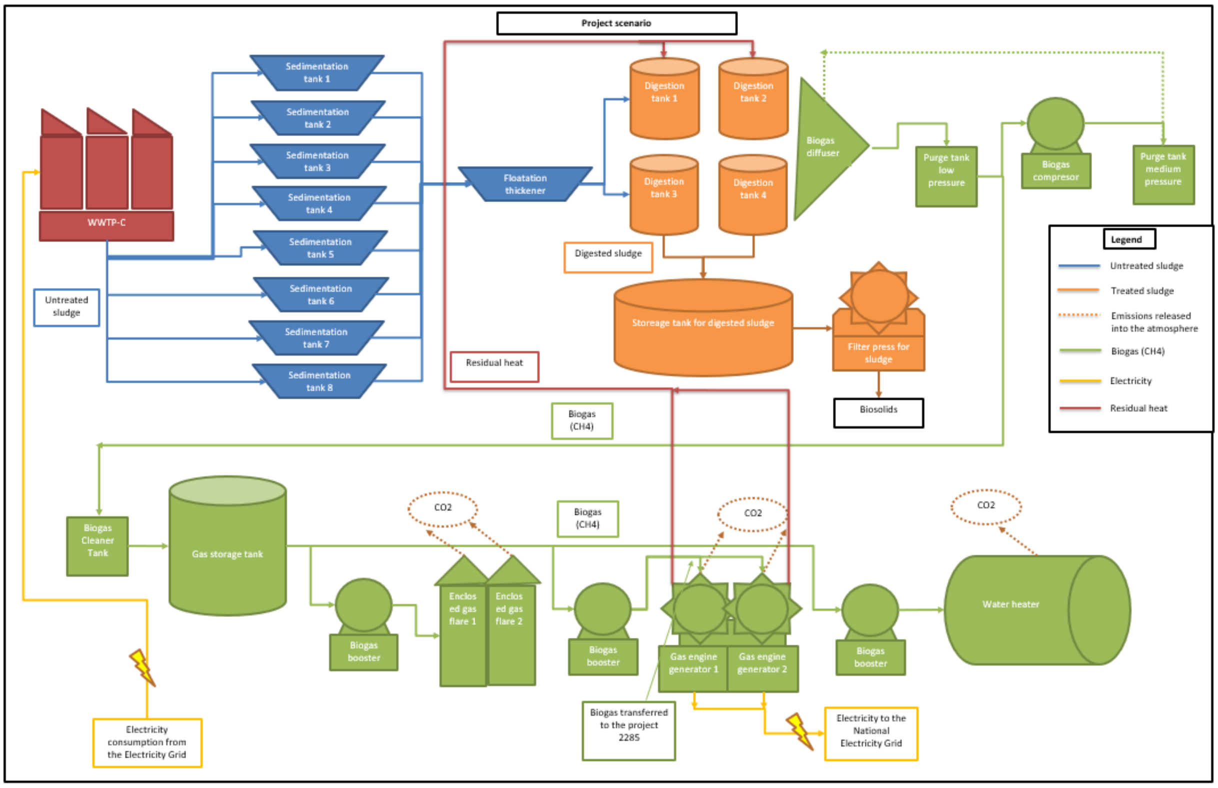
Figure 1: Sludge treatment line –WWTP-C. Baseline Scenario



The baseline scenario is the existing sludge treatment system without methane recovery and combustion.

This project category comprises measures that reduce the GHG emissions to the atmosphere by recovering the methane from biogenic organic matter in wastewaters by means of Introduction of methane recovery and combustion process to an existing sludge treatment system. The recovered biogas (methane) will be used for internal electricity consumption (or flared in case the internal consumption is met). The residual heat from electricity generation in the project activity scenario (figure 2) will be used to heat up the digestion tanks to maintain the sludge in the anaerobic digestion process at 35°C while in the baseline scenario (figure 1), the same anaerobic digestion conditions (35°C) were kept by a heater powered by the city's natural gas network. Therefore, since the heat to be supplied to the digestion tanks in the project activity is the same as it was in the baseline scenario, it can be demonstrated that the technology implemented does not increase the amount of methane produced per unit of COD removed compared with the technology used in the baseline so project emissions or leakage are not to be deducted from the emission reductions calculated from the methane recovered and combusted as per paragraph 34 of AMS III.H version 9. In fact, the utilization of the residual heat from electricity generation to heat up the digestion tanks in the project activity scenario is considered an energy efficiency measure as it reduces the amount of fossil fuel (natural gas) compared to the baseline scenario.

Figure 2: Sludge treatment line -WWTP-C, Project Scenario



The owner and operator of the proposed project activity is **EMPRESAS MUNICIPALES DE CALI - EMCALI**, **EICE ESP**. The mission of EMCALI is to contribute to the well-being and the development of the community of Cali by providing essential and complementary public services, committed to the environment and guaranteeing economic and social profitability. Among the services provided by EMCALI are telecommunications, water and sewer systems as well as electricity.

The plant was designed by NITOGOI and constructed by Degremont-Mitsubishi-Conciviles-Norbert Odebrecht -consortium contracted by EMCALI. The WWTP-C is designed to operate the average flow of 7.6 m³/s of the wastewater generated by the Municipality of Cali.

At the time of the development of the proposed project activity, emissions of methane are not regulated by any national environmental law. The Resolution 1096 of 2000[2] (all the annotations can be found in the end of the document) , which adopts the Technical Regulations for the Sector of Drinking Water and Basic Sanitation – RAS, indicate that wastewater treatment plants should establish the program of control of odors, mainly produced by anaerobic treatment systems. With this purpose the WWTP-C installed soil-beds which retain from the secondary gases compounds responsible for bad odors.

Having this in mind, the proposed project activity whose purpose is to reduce the greenhouse gas (GHG) emissions introduces the biogas combustion system once it has already removed compounds causing bad odors. Therefore, it is concluded that the activity of combusting of biogas is additional to national environmental regulations.

According to the Principles, Requirements and Criteria for the national approval of the projects that apply for CDM (Resolution 0453 of 2004 of the Ministry of Environment, Housing and Territorial Development[3] : – Designated National Authority for Colombia), the proposed project activity supports the sustainable development through its contribution to the principles of above mentioned Resolution:

1. Contribution to the long term improvement of the social and economic well-being of the local commune and the society in general, and
2. Implementation of cleaner production systems.

The **estimated amount of annual average GHG emission reductions is** 56,632 tCO_2e and the total amount GHG emissions reductions for the chosen credit period is 566,325 tCO_2e.

The proposed project activity is as well coherent with the state policy and planning. Furthermore, it contributes to the first principle “Contribution to the long term improvement of the social and economical well-being of the local comuna and the society in general” by its commitment to invest in the educational and environmental protection programs listed below:

1. Awarding scholarships to poor students who belong to the comuna neighboring the area of the project activity

2. Supporting neighboring schools or colleges through the donation of educational tools

3. Strengthening and spreading successful experience of recycling in the comunas 6 and 7.

The above mentioned programs form part of a larger umbrella Sustainable Development Program. The Management of Wastewater of EMCALI will bear the responsibility for the initiation of the umbrella program and the development of the above mentioned component-programs. The following activities have taken place to establish the content of these programs:

1. Designing social, economic, labor and environmental activities according to the necessities of the neighboring comuna and the employees of the WWTP-C.
2. Continuation of the initiatives and the current environmental activities led by the comuna in the area that EMCALI could support through its knowledge and availability of the resources
3. Execution of the concrete actions with a clear target and simple and applicable indicators.

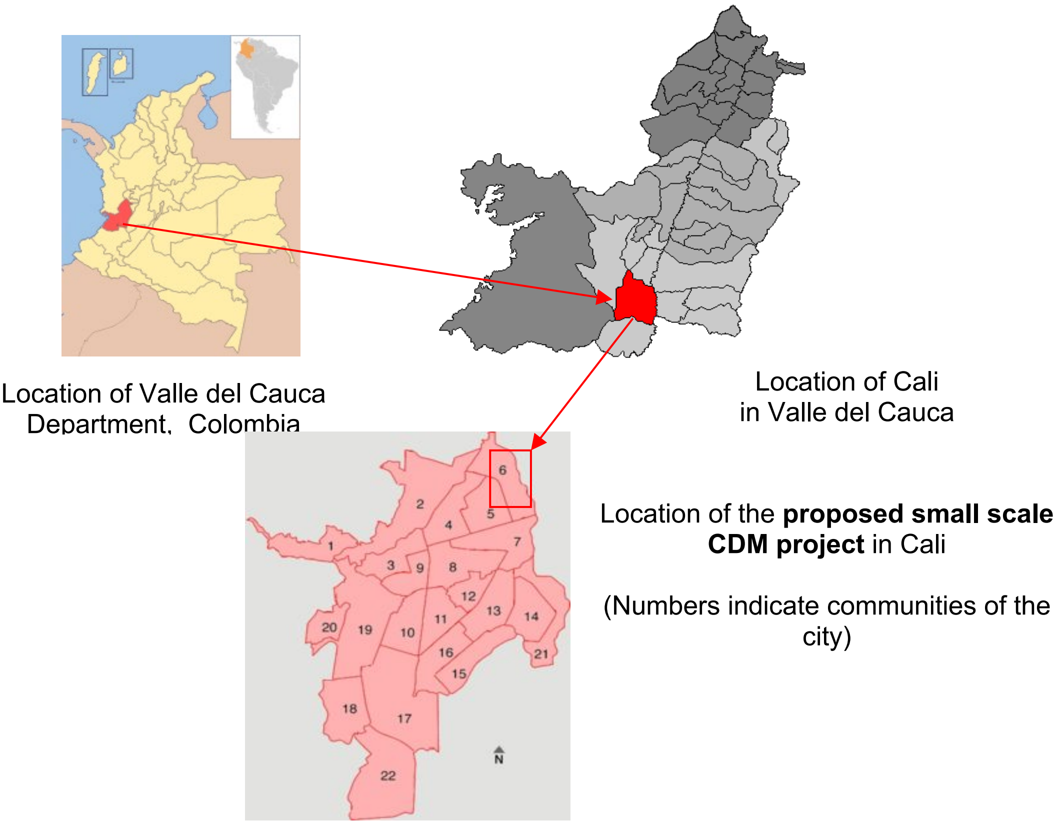
As a beginning stage of the project, the WWTP-C reviewed the environmental, social and economic studies made for the comunas 6 and 7, located nearby the plant[4]. Furthermore, the WWTP-C consulted representatives of the above mentioned comuna with regard to their most urgent necessities and their perception of the activities that the WWTP-C had developed to support them until that date.

The continuation of the execution of the activities under the Sustainable Development Program will be ensured by the creation of the Committee of Sustainable Development integrated by the representatives of the stakeholders of the proposed CDM project activity and the WWTP-C.

A.2. Location of project activity

Proposed project activity will take place inside the installations of the WWTP-C. The plant is located in the north-east part of Cali in the Department of Valle de Cauca on the total area of 22 hectares. The plant coordinates are: 3° 28' 10.06538" N, 76° 28´ 44.03571" W and the location height: 995 meters above sea level. Locally WWTP-C is situated in the comuna 6 in the Petecuy I neighborhood of Cali.

Figure 3. Geographical location of the proposed project



Picture 1: Wastewater Treatment Plant (WWTP) – Cañaveralejo, Cali, Colombia

A.3. Technologies/measures

Methane Recovery in Wastewater Treatment

This project category consists of the capture and combustion of biogas produced by organic matter present in generated sludge.

The proposed project activity conforms to the only measures that recover methane from biogenic organic matter in wastewaters by means of the “Introduction of methane recovery and combustion to an existing sludge treatment system" according to the option (iii) of the approved methodology Methane Recovery in Wastewater Treatment (AMS III.H, Version 09, Scope 13, Mar 28, 2008).

The recovered methane from the above measure will be utilized for the direct electrical energy generation, conform to the application (a) of the approved methodology Methane Recovery in Wastewater Treatment (AMS III.H, Version 09, Scope 13, Mar 28, 2008).

In alternative condition biogas will be combusted in flares and/or water heater (see the description of the Alternative procedures in section B.7.2 of the present document). In order to ensure the project adequate implementation and its subsequent operation a multi-facet approach for the sound and safe technology and know-how transfer was introduced. This approach involved careful identification and qualification of appropriate technology/services providers (worldwide acknowledged companies such as Mitsubishi Corporation, Degremont S.A., Waukesha, Leroy Somer and Kayanson), adequate selection of the technology solution, supervision of the complete project installation, the WWTP-C staff training and the development and implementation of a complete Monitoring Plan. As part of this process a technology solution that would be self-sustaining (i.e., highly reliable, low maintenance, and operate with little or no user intervention) had been implemented. Furthermore, the project executer ensures sound and safe application, operation and maintenance of all the equipment implemented in the WWTP-C for the purposes of the CDM project activity and will carefully monitor the data collection, recording processes and environmental and health safety (e.g. the equipment are fit with flame traps, H2S detectors, methane detectors, depressurization valves, flame controls, thermal protection of all the associated engines, fire hazard protection system, etc). Moreover, it will ensure that the staff acquires appropriate expertise and resources to operate the system on an ongoing/continuous basis. For more information, please refer to the description given in section B.5 of the present document.

To describe the technology to be implemented within the proposed project activity, the existing technology in the WWTP-C (existing without the project activity) is being explained below.

During the primary treatment of the wastewater of Cali, carried out in the WWTP-C, sludge composed of the organic matter susceptible to the decomposition is generated. The sludge is produced in eight sedimentation tanks and next carried into thickener tank. Later on sludge is redirected to four covered anaerobic digestion tanks (digesters) with the purpose of obtaining more stable end-product and eliminating pathogenic microorganisms present in the untreated sludge (see Figure 1). The above mentioned anaerobic digestion, besides stabilizing sludge, generates biogas with high content of methane (between 57% and 64% according to the latest analyses undergone in WWTP-C5). The flow of biogas and emissions is described in Figure 4 of this PDD.

<u>Description of the technology implemented within the CDM project activity:</u>

The equipment of the technology implemented within the activity of the CDM project for the methane capture and combustion is:

- gas storage tanks
- gas dehumidificator

- gas engine of the electric generator
- biogas flares
- water heater.

The gas captured is being stored in two cylindrical metallic tanks and next conveyed to a gas dehumidificators, later to be burnt in the generator`s internal combustion engines or, in alternative conditions, in flares and/or water heater. Each generator is a three-phase synchronic type devise, which possesses four strokes engines of internal high efficiency combustion and the ability to convey 1,054 kW at 1,200 rpm.

In order to optimize the processes in the plant, the water from the cooling of the generator's engines is used for the maintenance of the temperature of sludge in the digesters (between 33 to 35°C). This enables to control the optimum thermal conditions for the anaerobic digestion. In case the generation system fails some of the biogas will be redirected and burnt in the water heater which in such case is foreseen to maintain the temperature of sludge in the digesters.

Basic technical specifications of the biogas flare, water heater, dehumidificator, biogas storage tanks and generator's engine are: are:

<u>Gas storage tanks</u>

- Quantity: 2
- Volume: 1,000 m^3
- Diameter: 12.451 m
- Height: 13 m
- Lifetime: 5 years (conform to the estimations of the operating staff of the WWTP-C)

<u>Gas dehumidificator</u>

- Quantity: 1
- Inlet temperature: 30°C
- Relative Humidity: 100%
- Flow: 1,000Nm_3
- Pressure abs: 1,033 mbars
- Lifetime: 5-7 (conform to the information obtained from the official representative of Degremont in Colombia who installed the equipment in the WWTP-C).

<u>Gas engine generator</u>

- Type: Engine with the gas pre-chamber, 4 strokes, 4 valves
- Quantity: 2
- Operation: Automatic with output power and manual switch
- Cylinder no.: V-12
- Speed: 1,200rpm aprox.
- Fuel consumption: 2,651 Mcal/hr of biogas
- Lifetime 20 years and more (conform to the information obtained from the official representative of Waukesha Engine Dresser in Colombia (PEGSA Ltda)

<u>Enclosed Gas flare</u>

- Quantity: 2
- Power: 2.2 kW (gas booster)
    - kW (ventilator)
- Operation: Automatic with the level of biogas in the storage gas tank
- Flow: 550m^3/h

- Lifetime 20 years and more (conform to the information of the lifetime of the enclosed flares with similar technical specifications.

Water heater:

- Type: 3 lines
- Quantity: 1
- Capacity: 1,200 Mcal/h
- Power: 2.5 kW (gas booster)
- 7.5 kW (ventilator)
- Lifetime 25 years (conform to the information obtained from the producer – Kayanson Engineers).

It is important to emphasize that although the lifetimes of the dehumidificator and biogas storage tanks are foreseen to be shorter than the duration of the CDM project activity, in case it is necessary to replace them within this period, the project proponents will ensure their replacement with the equipment of equal or similar technical and operational specifications. In this way it will be ensured that the amount of the emission reductions achieved by the CDM project during the crediting period will not reduce due to the replacement of the existing equipment of the mentioned above project activity.

On the other hand, the equipmentof the project is included within the program of preventive and corrective maintenance which will keep ensuring its proper functioning. Furthermore, at the moment of its reparation or replacement, the time of the installation of the substitute equipment will be reduced to minimum to avoid eventual interference in the continuity of the project activity and the biogas will be combusted in different alternative ways in the flares and/or water heater. Under the alternative operation conditions, when the biogas might be combusted in the flares or in the water heater, the only electricity consumption might occur during the operation of the flares and such will be monitored and subtracted from the total emission reductions achieved by the project activity,. There are no diesel generators on site to feed the methane capture neither any other combustion plant (besides the biogas combustion engines of the electric generators).

The measurement equipment used for the different parameters is:

- Infrared methane concentration meters to measure volumetric fraction of methane.
- Volumetric flow meters will be used to obtain the Volumetric flow rate of biogas fed into the flares and engines. This information will be also recorded in the SCADA System.
- Thermocouple type K will be used to measure the temperature in the exhaust gas of the flares

The location of the measurement equipment is detailed in figure 5 of the PDD, section B.7.3.

A.4. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Colombia	Empresas Municipales de Cali, EMCALI, EICE ESP. Public Entity	Yes
Colombia	ALLCOT AG	Yes

A.5. Public funding of project activity

No public funding was involved in financing of the proposed project activity.

A.6. History of project activity

The proposed CDM project activity is neither registered as a CDM project activity nor included as a component project activity (CPA) in a registered CDM programme of activities (PoA). The proposed CDM project activity is not a project activity that has been deregistered. The project proponent declares that the proposed CDM project activity was not a CPA that has been excluded from a registered CDM PoA. On the other hand, there is a CDM project activity of the same project participant (ID 2285), nevertheless, in accordance with the paragraph 10 of the methodological tool, if a proposed small-scale project activity is deemed to be a debundled component but total size of such an activity combined with the previous registered small-scale CDM project activity does not exceed the limits for small scale CDM project activities as set in paragraph 6 (c) of the decision 17/CP.7,1 the project activity can qualify to use simplified modalities and procedures for small-scale CDM project activities. This is the case, since the sum of both annual emission reductions are less than 60ktCO_2/y, and therefore, small scale methodology is applied.

The main milestones of the project activity are following detailed:

Starting date of the project activity:

According to the Glossary of CDM Terms, v.4, the starting date of the project activity is March 31st, 2002 date of the first payments for capture and combustion system.

Prior consideration of the CDM and serious consideration of the CDM in the decision to implement the project activity according to the EB 48 Annex 61.

EMCALI shortly after the approval of the Kyoto Protocol by Colombia Act 629 of December 27th of 2000 and based on the extensive Study on the National Strategy for the CDM Implementation in Colombia of inter alia the World Bank and Colombian Ministry of Environment, April 2000 (*Estudio de Estrategia Nacional para la Implementación del MDL en Colombia*) on the national strategy for the implementation of CDM in Colombia, decided in a voluntarily and autonomous way to evaluate the feasibility of biogas capture and combustion in the future wastewater plant of Cañaveralejo within the scope of the possible benefits that could surface from the application of the premises of the Kyoto Protocol.

The aforementioned is evidenced by the internal conversation of EMCALI Strategic Programs Department of June 8th, 2001[11] and taken as an evidence of the earliest prior CDM consideration evidence. Additional proof constitutes another EMCALI internal letter dated of June 28th, 2001[12] in which the authorization for the implementation of the project is given as a result of the strong consideration by EMCALI of the benefits of the CDM in the realization of the project.

Demonstration of continuing and real actions taken (since the starting date of 31ST of March, 2002) to secure CDM status for the project in parallel with its implementation

The table below summarizes the events related to the CDM status for the project.

Date	Issue description
8th of June, 2001	Earliest CDM consideration evidenced in the internal communication of EMCALI.
28th of June, 2001	Further details on the consideration of the project as CDM, evidenced in the internal communication of EMCALI.
31st of March, 2002	Project starting date evidenced through the communication from Mitsubishi Project Development Department.
2nd of July, 2003	Project viability consultation of EMCALI to the Ministry of Environment, Housing and Territorial Development.
29th of October, 2004	Minutes of the Meeting between EMCALI and the Contract Consortium, related to the finalization of the sludge treatment plant contract and some pending items (capture and combustion).
25th of October, 2005	Communication between EMCALI Director of Residual Waters and Climate Change Manager of PricewaterhouseCoopers inviting the company (PwC) to present a proposal for CDM project development.
6th of June, 2006	Agreement between PwC and EMCALI for the development of the project as CDM.19
15th of September, 2006	Evidences of the barriers to the implementation of the project activity.
9th of January, 2007	Non Objection Letter of the Ministry of Environment, Housing and Territorial Development of Colombia (Colombian DNA) granted to the project.21
29th of April, 2008	Project Letter of Approval received from the Ministry of Environment, Housing and Territorial Development of Colombia (Colombian DOE)
20th of May, 2008	Clarification of the Letter of Approval granted to the project.

As it can be observed through the events listed in the above table EMCALI assured the CDM status for the project in parallel with its implementation.

A.7. Debundling

As per Methodological tool: Assessment of debundling for small-scale project activities Version 04.0 “A proposed small-scale project activity shall be deemed to be a debundled component of a large project activity if there is a registered small-scale CDM project activity or an application to register another small-scale CDM project activity:

(a) With the same project participants;

(b) In the same project category and technology/measure;

(c) Registered within the previous 2 years; and

(d) Whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point”.

There is a CDM project activity of the same project participant (ID 2285), nevertheless, in accordance with the paragraph 10 of the methodological tool, if a proposed small-scale project activity is deemed to be a debundled component but total size of such an activity combined with the previous registered small-scale CDM project activity does not exceed the limits for small scale CDM project activities as set in paragraph 6 (c) of the decision 17/CP.7,1 the project activity can qualify to use simplified modalities and procedures for small-scale CDM project activities. This is the case, since the sum of both annual emission reductions are less than 60ktCO_2/y and therefore, a small scale methodology can be applied

SECTION B. Application of selected methodologies and standardized baselines

B.1. Reference to methodologies and standardized baselines

Title: Methane Recovery in Wastewater Treatment

Reference: Appendix B of the Simplified Modalities and Procedures for Small-Scale CDM Project Activities (UNFCCC, 2005). Methane Recovery in Wastewater Treatment (AMS III.H, Version 09, Scope 13, Mar 28, 2008).

Tools referenced in this methodology:

- Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion
- Emissions from solid waste disposal sites
- Tool to calculate baseline, project and/or leakage emissions from electricity consumption

B.2. Applicability of methodologies and standardized baselines

Proposed project category: Methane Recovery in Wastewater Treatment (AMS III.H, Version 09, Scope 13, Mar 28, 2008).

The applicability conditions or the methodology are:

1. *This project category comprises measures that recover methane from biogenic organic matter in wastewaters by means of one of the following options:*

(i) Substitution of aerobic wastewater or sludge treatment systems with anaerobic systems with methane recovery and combustion
(ii) Introduction of anaerobic sludge treatment system with methane recovery and combustion to an existing wastewater treatment plant without sludge treatment
(iii) Introduction of methane recovery and combustion to an existing sludge treatment system
(iv) Introduction of methane recovery and combustion to an existing anaerobic wastewater treatment system such as anaerobic reactor, lagoon, septic tank or an on-site industrial plant
(v) Introduction of anaerobic wastewater treatment with methane recovery and combustion, with or without anaerobic sludge treatment, to an untreated wastewater stream
(vi) Introduction of a sequential stage of wastewater treatment with methane recovery and combustion, with or without sludge treatment, to an existing wastewater treatment system without methane recovery (e.g. introduction of treatment in an anaerobic reactor with methane recovery as a sequential treatment step for the wastewater that is presently being treated in an anaerobic lagoon without methane recovery).

The proposed project activity conforms to the measures that recover methane from biogenic organic matter in wastewaters by means of the “Introduction of methane recovery and combustion to an existing sludge treatment system" according to the option (iii) of the approved methodology Methane Recovery in Wastewater Treatment (AMS III.H, Version 09, Scope 13, Mar 28, 2008).”

2. *The recovered methane from the above measures may also be utilised for the following applications instead of combustion/flaring:*

(a) Thermal or electrical energy generation directly; or

(b) Thermal or electrical energy generation after bottling of upgraded biogas; or

(c) Thermal or electrical energy generation after upgrading and distribution:

(i) Upgrading and injection of biogas into a natural gas distribution grid with no significant transmission constraints; or

(ii) Upgrading and transportation of biogas via a dedicated piped network to a group of end users; or

(d) Hydrogen production.

Methane produced during the sludge anaerobic treatment will be utilized for the direct electrical energy generation, in accordance with the item (a) of the second applicability condition of the approved methodology In alternate condition biogas will be combusted in flares and/or water heater.

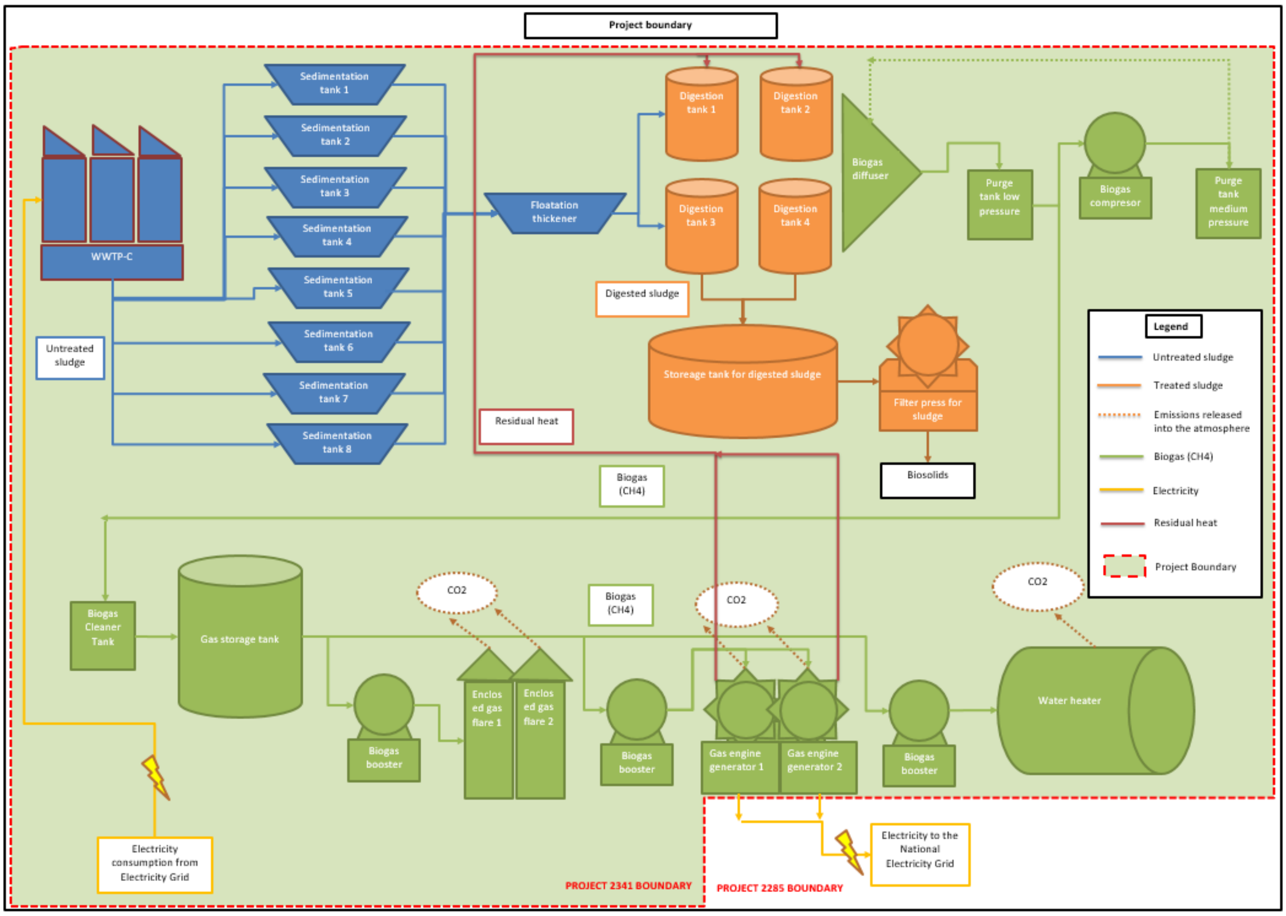
*Measures are limited to those that result in aggregate emission reductions of less than or equal to 60 kt CO2 equivalent annually from all type III components of the project activity*The annual estimated emission reductions of greenhouse gases will not exceed 60 ktCO_2e.

B.3. Project boundary, sources and greenhouse gases (GHGs)

The proposed project boundary is the physical site where the recovery of methane takes place. The geographical limit of the project activity is the city of Cali.

The following figure presents the sludge treatment line in the WWTP-C. Broken lines draw the boundary of the proposed project activity where it is shown that the sludge treatment is not modified, and the new equipment is installed only to capture and use the biogas. In blue colour the baseline equipment not modified because of the CDM project activity:

Figure 4: Proposed project activity boundary



Source		GHG	Included?	Justification/Explanation
Baseline	Sludge treatment system	CO_2	No	CO2 emissions from decomposition of the organic wastes are not accounted.
		CH_4	Yes	Main emission source in the baseline from anaerobic sludge digesters
		N_2O	No	Excluded for simplification. This is conservative.
	Electricity consumption	CO_2	No	Baseline emissions from electricity consumption for the baseline wastewater treatment system are excluded as this will be a very small quantity. Further, it is conservative to not include the baseline emissions from this source.
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
	Heat generation	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
	Wastewater treatment process	CO_2	No	CO2 emissions from decomposition of the organic wastes are not accounted.
		CH_4	Yes	Main emission source. The treatment of wastewater under the project activity may cause different emissions: (i) Methane emissions due to inefficiency of anaerobic sludge treatment; (ii) Methane emissions from flaring
		N_2O	No	Excluded for simplification.
	Electricity consumption	CO_2	Yes	CO2 emissions on account of power used by the project activity facilities.
		CH_4	No	Excluded
		N_2O	No	Excluded.

B.4. Establishment and description of baseline scenario

According to the methodology Methane Recovery in Wastewater Treatment (AMS III.H, Version 09, Sector 13, Mar 28, 2008) the baseline scenario will be one of the following situations:

(i) The existing aerobic wastewater or sludge treatment system, in the case of substitution of one or both of these systems for anaerobic ones with methane recovery and combustion
(ii) The existing sludge disposal system, in the case of introduction of anaerobic sludge treatment system with methane recovery and combustion to an existing wastewater treatment plant
(iii) The existing sludge treatment system without methane recovery and combustion
(iv) The existing anaerobic wastewater treatment system without methane recovery and combustion

(v) The untreated wastewater being discharged into sea, river, lake, stagnant sewer or

(i) flowing sewer, in the case of introducing the anaerobic treatment to an untreated wastewater stream

(vi) The existing anaerobic wastewater treatment system without methane recovery for the

(ii) case of introduction of a sequential anaerobic wastewater treatment system with methane recovery.

The baseline for the proposed project activity is the option (iii) - The existing sludge treatment system without methane recovery and combustion. This is the most probable scenario that would have continued in the WWTP-C if the advantages of CDM activity of capture and combustion of methane had not been identified.

For the calculation of the baseline emission, the equations presented in the methodology AMS III.H, Version 09, Scope 13, Mar 28, 2008 have been used as is explained in the point B.6.1.The parameters used for the calculation of the emissions of the baseline are described as follow:

Amount of untreated sludge generated in the year "y" ($S_{y,untreated}$):

Sludge, which during the anaerobic digestion generates biogas, is produced in batteries A and B of the WWTP-C. Each battery comprises four sedimentation tanks.

In order to determine the amount of sludge generated annually during the crediting period, a mass balance of the Total Suspended Solids TSS - was conducted. The calculation was made in conformity with the following equation:

$$S_{y,untreated} = (Q_y * TSS * \mu_{TSS\ removal}) / 10^6$$

Where:

$S_{y,untreated}$	quantity of untreated sludge generated in year "y" (tons)
Q_y	amount of influent wastewater to the WWTP-C in year "y" (m^3)
TSS	average concentration of total suspended solids (TSS) in influent wastewater entering the WWTP-C (178 mg/L)
$\mu_{TSS\ removal}$	average removal efficiency of TSS in the WWTP-C (fraction) (0.63)

The following table presents the estimation of the amount of sludge generated in WWTP-C.

Table 1: Estimation of sludge generated in WWTP-C

Year	Estimation of sludge generated in WWTP-C (tons)
2010	1,810,527
2011	1,830,351
2012	1,945,747
2013	1,975,336
2014	1,996,048
2015	1,999,007
2016	2,007,883
2017	2,012,913
2018	2,020,606

Degradable organic content of the untreated sludge in the year "y" ($DOC_{y,s,untreated}$):

There are no data of the degradable organic content of the untreated sludge - **$DOC_{y,s,untreated}$** available in the WWTP-C. Nevertheless, the default value of IPCC – 0.05 for domestic sludge of 10% of dry matter, present in the methodology AMS III.H, Version 09, Scope 13, Mar 28, 2008, had been corrected by the real % content of dry matter in the sludge generated in the sedimentation tanks of the WWTP-C according to the following relation:

$$\mathrm{DOC}_{y,s,untreated} = DOC_{DV} \times \frac{\%DM}{\%DM_{DV}}$$

Where:

$DOC_{y,s,untreated}$	Degradable organic content of the untreated sludge in the year "y"
DOC_{DV}	Default value of 0.05 of the degradable organic content for domestic sludge in wet basis, considering a default dry matter content of 10%.
%DM	1.21% - average % of dry matter in untreated sludge generated in the sedimentation tanks of the WWTP-C obtained through measurements. Annex 3: Baseline Information presents average % of the total solids in the untreated sludge of the year 2006 and 2007.
$\%DM_{DV}$	Default value of 10% of the percentage of dry matter in domestic sludge.

As the outcome of the calculation, the value of 0.0061 of the fraction of organic content in the untreated sludge in the WWTP-C has been taken for further calculations.

<u>Fraction of DOC dissimilated to biogas (DOC_F):</u>

IPCC default value of 0.5 (as indicated in the methodology AMS III.H, Version 09, Scope 13, Mar 28, 2008) was taken for further calculations.

Fraction of CH_4 in landfill gas (F):

The IPCC more conservative default value of 0.5 (AMS III.H, Version 09, Scope 13, Mar 28, 2008) was taken for further calculations.

Methane correction factor for the sludge treatment system that will be equipped with methane recovery and combustion ($MCF_{s,treatment}$):

The value of the correction factor for the anaerobic untreated sludge digestion tanks of 0.8 (AMS III.H, Version 09, Scope 13, Mar 28, 2008) was taken for further calculations.

B.5. Demonstration of additionality

Identification of alternative scenarios

Definition of alternative scenarios to the proposed CDM project activity

The following scenarios were identified as alternative to the CDM project activity:

Alternative 1: Direct release of methane present in biogas to the atmosphere. Biogas is a product of an anaerobic treatment of the sludge in the WWTP-C and would be released after the removal of the components of the gas that cause bad odors.

Alternative 2 (proposed project activity being undertaken without being registered as a CDM project activity): Introduction of the capture and high efficiency combustion of biogas, once having removed the components of the gas causing bad odors, in the engines of the electric generator. Biogas is a product of an existent anaerobic sludge treatment of the WWTP-C.

Consistency with mandatory applicable laws and regulations

Fulfilling environmental regulations:

Introduction to the national environmental regulatory obligations.

As per item 15 of Article 8 of National Decree 1735 of 1994, Regional Autonomous Corporate Entities are entitled in their related jurisdiction to grant the environment license to build and operate sewer systems, marginal interceptors, systems and pump stations and treatment plants and final disposition of wastewater of territorial entities. Afterwards, Article 9 of Decree 1220 of 2005 from the Ministry of Environment, Housing and Territorial Development of Colombia adopts such statement clarifying that environmental authorities incorporated by means of Act 768 of 2002 are entitled to grant or deny the environmental license to build and operate wastewater treatment systems at the service of towns over or equal 200,000 inhabitants.

In line with the above stated EMCALI was granted an environmental license for the new designs of the WWTP-C through the Resolution No. 0064 of January 22nd, 2002 and through the Resolution No. 0370 of April 30th, 2002 was granted a license for the disposal of the biosolids generated in the Plant.

Having said the above, at the moment of the preparation of the present PDD the WWTP-C counts with all the necessary licenses and permits. With respect to the proposed CDM project activity,

according to the Decree 1220 of 2005[24], art. 9 biogas capture and combustion does not require environmental license.

Specific requirements with respect to the wastewater treatment plants

In Colombia in order to dispose sludge generated in the wastewater treatment plant the following regulations have to be fulfilled: the Resolution 1096 of November 17th of 2000[25] that adopts the Technical Regulations for the Sector of Drinking Water and Basic Sanitation – RAS. The technical resolution indicates that the sludge:

- cannot be disposed neither in superficial nor underground water bodies,
- have to be stabilized and
- Program of control of odors and pathogenic organisms has to be established (the characterization of the pathogenic organisms has to be included).

The sludge produced in the sedimentation tanks during the treatment of domestic wastewater in the WWTP-C is further taken to the anaerobic digestion system with the purpose to obtain more stable final product and eliminate any pathogenic microorganisms present in the untreated sludge.

Anaerobic digestion carried out at the WWTP-C, in addition to produce a more stable sludge in conformity with the environment regulation in force, generates a high methane content biogas, which requirement for combustion is not considered by any statement of the Resolution 1096 of 2000 - or any other national environment regulation. The above mentioned Resolution sets forth that every anaerobic treatment plant, such as Cañaveralejo, shall have a system that allows the biogas management and final disposal that do not generate negative impact towards the community inhabiting the surrounds of the treatment plant, either from the explosions or odors. The aforementioned regulation is tackled by:

1. Implementation of the odor control system of the wastewater line at the WWTP-C, including the air extractor system to collect gases generated from the wastewater treatment and afterwards, conducted through ducts to the soil beds – ground layers - where the odor components are removed due to the microorganisms' action. On the other hand, the biogas generated in the digesters passes through the purifier with continuous regeneration that uses a bed of iron sponge as the active media to remove hydrogen sulfide. The sponge consists of wood shavings impregnated with hydrated form of iron oxide. As the biogas passes through the purifier, hydrogen sulfide is removed by reacting with the iron oxide to form ferric sulfide. To regenerate the sponge, oxygen is needed to reconvert the ferric sulfide to iron oxide. In the continuous regeneration system, a small amount of air (less than 5% total flow) is added to the gas flow to regenerate the media. The effluent gas has the concentration of hydrogen sulfide of less than 10 ppm.

In order to minimize the explosion risks at the WWTP-C, a set of alternative procedures were established to manage gas. In such a way, the WWTP-C owns safety elements, such as flame traps, H_2S detectors, methane detectors, depressurization valves, and flame controls. In addition to the above, all electrical equipment installed in the five digesters, including lamps, switches, cable ducts, etc., are explosion proof.

As a conclusion, the WWTP-C owns an odor control system and is duly protected against explosion risks due to gas management.

Concluding, based on the study of binding national regulation, at the moment of the elaboration of this PDD, neither exists nor it is foreseen to be imposed at least in the following 10 years of the duration of the proposed CDM activity - the regulation nor any other policy requiring the biogas capture and/or combustion or the control of methane emissions.

Based on the study of binding national environment regulation (see the description of the environmental law requirements given above), two of the identified alternatives comply with the national environmental requirements as:

- Alternative 1 allows emission of the biogas once the traces of components causing bed odors are removed.
- Alternative 2 aims at the high efficiency combustion of methane generated from the sludge digesters once the traces of components causing bed odors are removed.

Additionally, it is concluded that the activity of the proposed CDM project activity of methane capture and high efficiency combustion is additional to the compliance with the national environmental regulation.

Barrier analysis

Alternative 2 in comparison with Alternative 1 is more technologically advanced, leads to less emissions of GHG gases but presents certain risks due to performance uncertainty. The following barriers were identified on the basis of the Attachment A to Appendix B of the Simplified Modalities and Procedures for Small-Scale CDM Project Activities (version 7, November 28, 2005). Nevertheless the above mentioned Attachment requires the explanation of at least one of any of the appointed in this attachment barriers, the project proponent elaborated three of them as presented below:

(a) Technological barriers:

Alternative 1 does not present technological barriers.

Alternative 2 has the following barriers identified:

Since the start-up of the combustion of biogas in the high efficiency electric generator's engine, technical difficulties occurred that prevented the system from achieving high combustion efficiency for more than 3 years. These technological obstacles have been related to the biogas humidity that caused the corrosion of the combustion equipment and the instability of the combustion system itself. As the biogas that is being generated in the existent digestion tanks of the WWTP-C is characterized by high concentration of humidity, it requires continuous additional treatment technology[6].

In the consequence of the appearance of the technological difficulties mentioned above and the lack of the staff neither the organizational technical capacity necessary for reaching and maintaining the high efficiency combustion in the electric generators engines, it was necessary for the administration of the WWTP-C to invest in the special technical assistance.

This technical assistance was searched among the specialized technical staff of Mitsubishi in order to develop internal technical capacity of the WWTP-C staff[7] and to adequate the operation of the methane capture and high efficiency combustion, which full implementation has not been achieved until the moment of the finalization of the elaboration of the present document (more information available upon a request).

(b) Barriers due to prevailing practice:

Alternative 1 does not present the barrier due to the prevailing practice, as the release of biogas generated in the wastewater treatment plants (after having removed its components causing bed odors) is a common practice in Colombia.

According to the official data of the Superintendence of the Domestic Public Services in Colombia (es. Superintendencia de Servicios Públicos Domiciliarios) reported in the Unique Information System of the Public Services (es. Sistema Único de Información de Servicios Públicos)[8] until now does not exist the information of any wastewater treatment plant pertaining to the municipal public service utilities that counts with the implemented system of methane capture and high efficiency combustion.

However having in mind the primary initiative of EMCALI and the progress of its project (WWTP-Cañaveralejo), other public services utilities, which possess the municipal wastewater treatment plants, have expressed to the Colombian Office for Climate Change their interest to develop projects similar to the one currently implemented by EMCALI.

On the other hand in what is referred to as private sector exist other methane capture and combustion initiatives among which stands out the one of palm industry (according to the information of the Colombian Office for Climate Change[9]). Nevertheless, this initiative pertains to the subitem (v) of the Methodology AMS III.H (Version 09, Scope 13, Mar 28, 2008), which is deferent to the one implemented in the WWTP Cañaveralejo (subitem (iii) of mentioned above methodology).

Based on the information given above it is concluded that the Alternative 2 contrary to Alternative 1, of biogas capture and high efficiency combustion with the purpose different than the removal of the gas component that cause bad odors is not a prevailing practice in Colombia and it is not required by the national law (as described under the point “Fulfilling environmental regulations”).

c) Other barriers

The core business of EMCALI consists of the wastewater treatment and as such does not include the activity of biogas capture and high efficiency combustion. The development of such activity meant the gradual change of the basic concept of EMCALI´s business, that on the other hand, entailed the series of changes in the traditional way of thinking; called for competent staff to deal with this new and challenging subject of capture and combustion of biogas, required new technology, equipment and series of trainings preparing the internal staff of EMCALI to take up this new activity. These topics were not popular among the EMCALI´s Board Directors. As such, the barrier did not exist for the Alternative 1, as EMCALI would continue with their business as usual and on contrary, it presented a specific barrier to the Alternative 2 that without CDM wouldn’t be encouraged to overcome it and would not develop the necessary staff competence and technological capacity.

Common practice analysis

No similar activities to the biogas capture and high efficiency combustion in the wastewater plants with the purpose different than the removal of the gas components causing bad odors can be observed in Colombia (see the explanation given under point (b) Barriers due to prevailing practice).

Conclusion

Finally, it is concluded that the Alternative 1 is the most probable scenario EMCALI would follow allowing the biogas generated during the anaerobic treatment of the sludge in the WWTP-C to escape to the atmosphere once having the components responsible for bad odors removed, and only with the incentive such as MDL, it is possible to overcome technological barriers and barriers

due to the prevailing practice and implement the Alternative 2, which is the proposed CDM project activity.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

Project activity emissions:

In accordance with the approved monitoring methodology AMS III.H Methane recovery in wastewater treatment (Version 09, Scope 13, Mar 28, 2008), project activity emissions consist of:

$$PE_y = PE_{y,power} + PE_{y,ww,treated} + PE_{y,s,final} + PE_{y,fugitive} + PE_{y,dissolved} + PE_{y,upgrading} + PE_{y,leakage,pipeline}$$

Where:

PE_y	Project activity emissions in year "y" (tCO_2e)
$PE_{y,power}$	Emissions from electricity or diesel consumption in year "y"
$PE_{y,ww,treated}$	Emissions from degradable organic carbon in treated wastewater in year "y"
$PE_{y,s,final}$	Emissions from anaerobic decay of the final sludge produced in year "y"
$PE_{y,fugitive}$	Emissions from methane release in capture and utilization/combustion/flare systems in year "y"
$PE_{y,dissolved}$	Emissions from dissolved methane in treated wastewater in year "y"
$PE_{y,upgrading}$	Emission related to the upgrading and compression of biogas in year "y"
$PE_{y,leakage,pipeline}$	Emission due to the physical leakage from the dedicated piped network in year "y"

Relevant to the proposed project activity is the following formula:

$$PE_y = PE_{y,fugitive} + PE_{y,power}$$

The reasons for leaving out other formula components are:

$PE_{y,ww,treated}$	Introduction of a recovery and combustion to an existing sludge treatment system does not changes the amount of methane produced per unit of COD removed. Having the aforementioned in mind, the content of degradable organic carbon in treated wastewater is expected to be the same in the baseline as in the project activity and therefore, this term is not relevant for further calculations.
$PE_{y,s,final}$	Introduction of a recovery and combustion to an existing sludge treatment system does not changes the amount of methane produced per unit of COD removed. Having the aforementioned in mind, the amount and characteristics of the sludge produced in the baseline scenario will not change in the proposed project activity and therefore, this term is not relevant for further calculations.
$PE_{y,dissolved}$	Introduction of a recovery and combustion to an existing sludge treatment system does not changes the amount of methane produced per unit of COD removed. Having the aforementioned in mind, the amount and characteristics of methane dissolved in treated wastewater in the baseline scenario will not change in the proposed project activity and therefore, this term is not relevant for further calculations.

$PE_{y,upgrading}$	The recovered methane is not upgraded for bottling, therefore, this term is neglected.
$PE_{y,leakage,pipeline}$	There are no emission due to the physical leakage from the dedicated piped network for transport of upgraded biogas to the end users in the proposed project activity, therefore, this term is not relevant for further calculations.

$PE_{y,power}$: Emissions from electricity or diesel consumption in year "y"

The most of the energy used for the purposes of the operation of the WWTP-C comes from biogas that is captured and combusted within the WWTP-C. Nevertheless, in few cases (for the operation of the flares and the water heater) electricity can be taken from the grid. This parameter is considered in the calculations even though that these emissions will be negligible.

Project activity emissions from electricity consumption are determined as per the procedures described in the latest version of the AMS I.D (Grid connected renewable electricity generation) at the moment of the registration of the project activity (version 13.0) Grid electricity will not be consumed for the purposes of the operation of the project in the regular operation of the WWTP-C. Nevertheless, if case that it occurs, the electricity consumption consisting exclusively of the consumption for the operation of the flares and water heater, will be monitored and subtracted from the total emission reductions achieved by the project activity.

The amount of the grid electricity consumed for the operation of the flares will be included in the total value of the GHG project emissions during a given year "y" according to the formulas presented below:

$$PE_{y,power} = EC_y * FE$$

PE_y	Project activity emissions in year "y"
EC_y	Grid electricity consumption for the operation of the flares in year "y"
FE	Emission factor for grid electricity in year "y"

Grid electricity consumption for the operation of the flares in year "y" will be determined by the measurement of the operation hours multiplied by the name plate of the flaring equipment 3.3 kW (2.2 kW - gas booster + 1.1 kW – ventilator, according to the technical specification of the equipment). The operational time of the flares will be registered in SCADA, Control and Acquisition Data System for 10+2 years beginning from the start of the project operation – see above the description of the system.

Grid electricity consumption for the operation of the water heater in year "y" will be determined by the measurement of the operation hours of the water heater multiplied by the name plate of of the water heater 10.0 kW (2.5 kW - gas booster + 7.5 kW – ventilator, according to the technical specification of the equipment). The operational time of the water heater will be registered in SCADA, Control and Acquisition Data System for 10+2 years beginning from the start of the project operation – see above the description of the system.

Emission factor of the national electricity system will be calculated ex-post in accordance with the methodology AMS-I. D (version 13.0) as it is stated in methodology AMS-III.H (version 09). In case an official value is published by the official government this value will be used.

$PE_{y,fugitive}$: Emissions from methane release in capture and utilization/combustion/flare systems in year "y"

$$PE_{y,fugitive} = PE_{y,fugitive,ww} + PE_{y,fugitive,s}$$

Where:

$PE_{y,fugitive,ww}$	Fugitive emissions through capture and utilization/combustion/flare inefficiencies in the anaerobic wastewater treatment in year "y" (tCO_2e)
$PE_{y,fugitive,s}$	Fugitive emissions through capture and utilization/combustion/flare inefficiencies in the anaerobic sludge treatment in year "y" (tCO_2e).

As the recovery and combustion will be introduced only to an existing anaerobic sludge treatment system, the emissions will be associated only to the fugitive emissions from the capture and utilization/combustion/flare inefficiencies in this system. There will be no change in the anaerobic wastewater treatment between the baseline and the proposed project activity, therefore, $PE_{y,fugive,ww}$ = 0.

The project emissions could be produced only due to the capture and combustion efficiency of the methane recovery system. In methodology AMS III.H Methane recovery in wastewater treatment (Version 09, Scope 13, Mar 28, 2008) the combustion efficiency is included in the capture efficiency of the system.

For these combined project emissions, a default value can be used.

$$PE_{y,fugitive,s} = (1 - CFE_s) * MEP_{y,s,treatment} * GWP\_CH4$$

Where:

CFE_s	Capture and utilization/combustion/flare efficiency of the methane recovery and combustion/utilization equipment in the sludge treatment (a default value of 0.9 shall be used, given no other appropriate value)
$MEP_{y,s,treatment}$	Methane emission potential of the sludge treatment system in the year "y" (tonnes)
GWP_CH4	Global Warming Potential for methane

$$MEP_{y,s,treatment} = S_{y,untreated} * DOC_{y,s,untreated} * DOC_F * F * 16/12 * MCF_{s,treatment}$$

Where:

$S_{y,untreated}$	Amount of untreated sludge generated in year "y" (tons)
$DOC_{y,s,untreated}$	Degradable organic content of the untreated sludge generated in the year y (fraction). It is estimated ex ante using the IPCC default values of 0.05 for domestic sludge (wet basis, considering a default dry matter content of 10 percent) or 0.09 for industrial sludge (wet basis, assuming dry matter content of 35 percent)
$MCF_{s,treatment}$	Methane correction factor for the sludge treatment system that will be equipped with methane recovery and combustion (MCF higher value of 1.0 as per table III.H.1 of the methodology AMS III.H Methane recovery in wastewater treatment, Version 09, Scope 13, Mar 28, 2008).

Nevertheless, this project emissions ($PE_{fugitive,y}$)should be taken into consideration in case that the project activity implies any change in the sludge treatment, which it will not be the case. The amount of untreated sludge generated ($S_{y,untreated}$) will be the same than in the baseline scenario, therefore,

the potential to generate methane are equal in the baseline and the proposed project activity. For this reason, $MEP_{y,s,treatment}$ is considered zero in the ex post calculations..

Baseline Emissions:

$$BE_y = MEP_{y,ww,bl} * GWP\_CH4 + MEP_{y,s,treatment} * GWP\_CH4$$

Where:

BEy	Baseline emissions in year "y" (tons CO_2e)
$MEP_{y,ww,bl}$	Methane emission potential of the anaerobic wastewater treatment plant(s) in the baseline situation in year "y" (tons)
$MEP_{y,s,treatment}$	Methane emission potential of the sludge treatment system in the year "y" (tons)
GWP_CH4	Global Warming Potential for methane (value of 21 is used).

$$BE_y = MEP_{y,s,treatment} * GWP\_CH4$$

On the other hand, as per paragraph 36 of the applied methodology, in all cases, the amount of methane recovered, fuelled, flared or utilized (e.g. injected into a natural gas distribution grid or distributed via a dedicated piped network) shall be monitored expost, using continuous flow meters. The fraction of methane in the gas should be measured with a continuous analyser or, alternatively, with periodical measurements at a 95% confidence level. Since the project activity will be using thermo-mass flowmeters, it is not necessary to measure temperature and pressure of the gas to determine the density of methane combusted.

$$MEP_{y,s,treatment} = S_{y,untreated} * DOC_{y,s,untreated} * DOC_F * F * (16/12) * MCF_{s,treatment}$$

Where:

$S_{y,untreated}$	Amount of untreated sludge generated in year "y" (tons)
$DOC_{y,s,untreated}$	Degradable organic content of the untreated sludge generated in the year y (fraction). It is estimated ex ante using the IPCC default values of 0.05 for domestic sludge (wet basis, considering a default dry matter content of 10 percent) or 0.09 for industrial sludge (wet basis, assuming dry matter content of 35 percent)
DOC_F	Fraction of DOC dissimilated to biogas (IPCC default value of 0.5)
F	Fraction of CH_4 in landfill gas (IPCC default of 0.5)
$MCF_{s,treatment}$	Methane correction factor for the sludge treatment system that will be equipped with methane recovery and combustion (MCF Lower value table III.H.1 of the methodology AMS III.H Methane recovery in wastewater treatment, Version 09, Scope 13, Mar 28, 2008).

Leakage due to the project activity:

Since the used technology does not involve equipment transferred from another activity and the existing equipment is not transferred to another activity, no leakage needs to be considered.

Emission reductions of the project activity:

As per paragraph 34 of AMS-III.H. (version 9.0), for the case (iv) introduction of methane recovery and combustion unit to an existing anaerobic wastewater or sludge treatment system, the calculation of emission reductions shall be based on the amount of methane recovered and fuelled or flared, that is monitored ex-post. Also for these cases, the project emissions and leakage will be deducted from the emission reductions calculated from the methane recovered and combusted considering that the technology implemented does not increase the amount of methane produced per unit of COD removed compared with the technology used in the baseline (since both are the same).

$$ER_y = BE_y - PE_y - Leakage$$

Where:

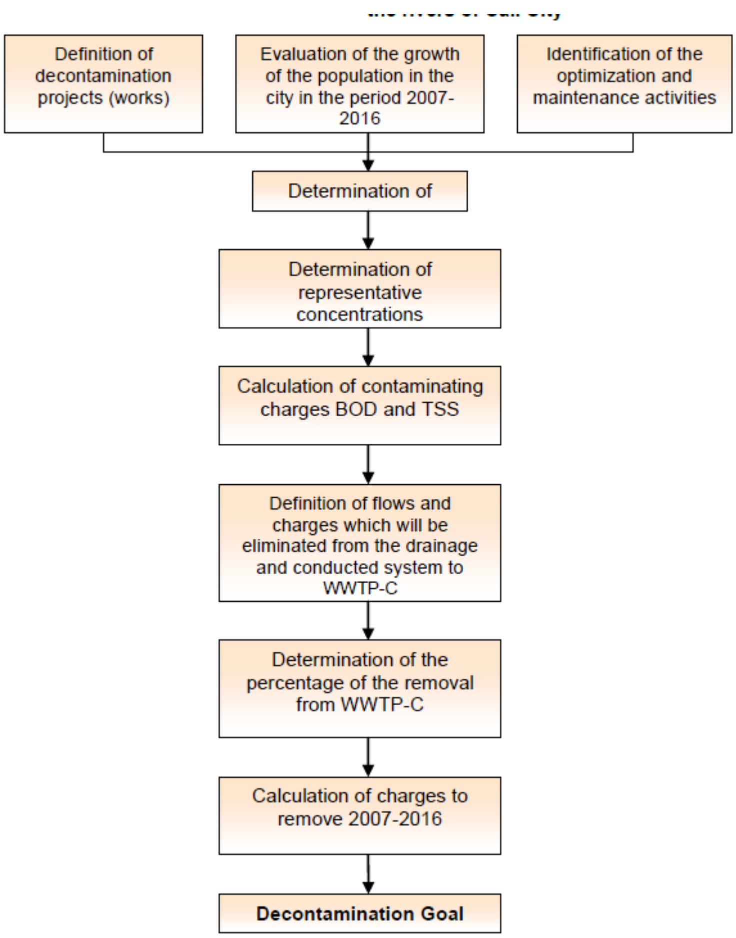
BE_y	Baseline emissions in the year “y” (tCO_2e)
PE_y	Project activity emissions in the year “y” (tCO_2e)
Leakage	Not considered in further calculations

B.6.2. Data and parameters fixed ex ante

<table>
<tr><td>Data/Parameter</td><td>Qy</td></tr>
<tr><td>Data unit</td><td>m^3/year</td></tr>
<tr><td>Description</td><td>The flow of influent wastewater to the WWTP-C in year “y” of a crediting period</td></tr>
<tr><td>Source of data</td><td>Estimations of the Planning Department of EMCALI</td></tr>
<tr><td>Value(s) applied</td><td>
<table>
<tr><th>Year</th><th>Estimation of the flow of influent wastewater to PTAR-C (m^3/year)</th></tr>
<tr><td>2008</td><td>140,781,960</td></tr>
<tr><td>2009</td><td>186,111,596</td></tr>
<tr><td>2010</td><td>189,109,408</td></tr>
<tr><td>2011</td><td>191,180,062</td></tr>
<tr><td>2012</td><td>203,233,121</td></tr>
<tr><td>2013</td><td>206,323,649</td></tr>
<tr><td>2014</td><td>208,487,019</td></tr>
<tr><td>2015</td><td>208,796,072</td></tr>
<tr><td>2016</td><td>209,723,230</td></tr>
<tr><td>2017</td><td>210,248,620</td></tr>
<tr><td>2018</td><td>211,052,157</td></tr>
</table>
</td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>EMCALI, based on the extensive study of the Planning Department of EMCALI “Sanitation and wastewater management plan for the years 2007-2016”, foresees the increase of influent wastewater to the WWTP-C as the function of three following components: definition of the decontamination projects, evaluation of the growth of Cali in the following years and the identification of the optimization and maintenance activities in the city. It needs to be emphasized that the increase of wastewater inflow is NOT due to the activity of the proposed CDM project but due to the three components already mentioned above inherent to the development of the city of Cali.

EMCALI realized a diagnostic of the sewer system of the city. Main wastewater streams were identified and the causes with possible solutions were evaluated. Some of the solutions are oriented into the optimization of the grids, having in mind that this action would reduce wastewater that due to false functioning is conducted to canals and rivers; other works are connected to the implementation of the sanitary collectors that will block and redirect wastewaters to the WWTP-C that currently are disposed by some of the sectors in an inadequate way; in other cases a necessity for the optimization of the separation and improvement structures of the sewer maintenance system of the city was identified. For a better understanding of the methodology applied, a graph below presents the steps taken for the calculation of the Decontamination Goal. To project the population of Cali the information of the Administrative Department of Planning DAP-97 was taken into account, having in mind that DANE (the Administrative Department of the Municipal Planning) only registered the population in year 2005 without further projections. On the other hand, Registry 2005 presented the number of habitants for the city of Cali similar to the numbers projected by DAP- 97, which allows deducing that the projections would proceed with the same tendency.

For the ex-ante calculations of the baseline and the project activity emissions more conservative scenery for the growth of the population, decontamination projects and the optimization and maintenance activities was adopted, i.e., 25 percent in 2008 and 2 percent uncertainty level for years 2009-2018 in comparison with the initial projection presented by EMCALI[26]. This higher uncertainty level of 25% for the year 2008 was adopted due to the unexpected delay in the planned by EMCALI for this year maintenance and expansion of the sewer system grid. These works are delayed in function of other constructions being developed in Cali by the municipality (for example, the constructions of massive transportation system for Cali – MIO by acronyms in Spanish). It is foreseen that this delay resulting in the lower wastewater inflow to the WWTP-C will extend only over the year 2008 and therefore, the following years would continue with the 2% uncertainty level.</td></tr>
</table>

Choice of data or measurement methods and procedures	The result of these calculations is available upon the request. At the moment of the preparation of the present document, no other policies, plans, strategies or regulations are known to present risks to the calculation of the baseline emissions and therefore no higher uncertainty level to the one already included in the estimation of the amount of the inflow wastewater (25% in 2008 and 2% in the rest of the years of the crediting period) was included in the calculation. **Figure 5: Flow graph for the calculation of the decontamination goal of the rivers of Cali City** 
Purpose of data	Calculation of emissions reductions
Additional comment	The calculation of the GHG emission reduction will be based on the direct measurement of the amount of methane captured and used as fuel in the engine of the electric generator or burned as emergency in the flares or water heater. Once the project is implemented, this parameter will not be necessary for the calculation.

Data/Parameter	**TSS**
Data unit	g/m^3
Description	Average concentration of total suspended solids (TSS) present in the influent wastewater entering the WWTP-C.
Source of data	Average of measurements made by the WWTP-C´s laboratory during the last three years of the WWTP-C operation (2004, 2005 and 2006). Data are stored in the Process Area.
Value(s) applied	184
Choice of data or measurement methods and procedures	The WWTP-C´s Laboratory takes a daily hourly samples comprised by influent wastewater in quotas proportional to the flow volume entering the WWTP-C. The total suspended solids (TSS) are determined by means of the gravimetric technique aforementioned in the Standard Methods for the Examination of Water and Wastewater, Edition 20, as per Methodology 2540D; for dry conditions between 103-105C. Data of the TSS analysis are daily introduced by the Laboratory stuff (Administrative Analyst) into the form "Tab.1 Parámetros fisicoquímicos I agua cruda". The data are next revised and "published" in intranet by the Laboratory Chief (Professional of the Supporting Process). Data with the analysis are archived for 10 years in paper copy in folder no. 5 "Informes Análisis Línea de Agua WWTP-C" for each year. The Process Area has direct access to the data already "published" in intranet and is able to process them. The Process Area prepares every month, semester and year reports of the functioning of the Plant. Based on these data from the last 3 years (2004, 2005, 2006) the average concentration of TSS in influent wastewater entering the WWTP-C was calculated. Detailed calculation is available upon the request.
Purpose of data	Calculation of emission reduction
Additional comment	The calculation of the GHG emission reduction will be based on the direct measurement of the amount of methane captured and used as fuel in the engine of the electric generator or burned as alternative in the flares or water heater. Once the project is implemented, this parameter will not be necessary for the calculation.

Data/Parameter	$\mu_{removal}$ **TSS**
Data unit	Fraction
Description	Average efficiency of the removal of TSS in the WWTP-C
Source of data	Average of measurements made by the WWTP-C´s laboratory during the last three years of the WWTP-C operation (2004, 2005 and 2006). Data are stored in the Process Area.
Value(s) applied	0.6
Choice of data or measurement methods and procedures	TSS removal efficiency depends on the sedimentation tanks operation. It is possible to apply this efficiency to calculate the sludge produced which afterwards is taken to the anaerobic digesters. The average sedimentation tanks efficiency varied in years 2006 and 2007 between 63 and 67% (efficiency of the TSS removal). For the purposes of the calculation of the amount of sludge - lower, more conservative value was adopted.
Purpose of data	Calculation of emissions reduction
Additional comment	The calculation of the GHG emission reduction will be based on the direct measurement of the amount of methane captured and used as fuel in the engine of the electric generator or burned as alternative in the flares or water heater. Once the project is implemented, this parameter will not be necessary for the calculation.

Data/Parameter	**%DM**
Data unit	Percentage
Description	Percentage of dry matter from untreated sludge generated from the WWTP-C sedimentation tanks.
Source of data	Average of measurements made by the WWTP-C´s laboratory. Data is stored in the Process Area.
Value(s) applied	1.21
Choice of data or measurement methods and procedures	According to the Methodology AMS III.H, Version 09, Scope 13, Mar 28, 2008, the default value for the fraction of degradable organic content of non-treated sludge ($DOC_{y,s,untreated}$) is 0.05. Such value relates to domestic sludge in wet basis, considering 10% of dry matter. Due to the fact that dry matter from non-treated sludge at the WWTP-C is substantially different from the value reported by the Methodology, the value was amended. Section B.4 shows details of the calculation, and Appendix 3 Baseline information, shows the monthly average data for 2006 and 2007 of the content of total solids (TS) in non-treated sludge. The WWTP-C laboratory takes specific samples twice a day from the sludge flowing out from each sediment tanks. The total suspended solid (TSS) is determined by means of the gravimetric technique as per Methodology 2540H for solids and semisolids as per the Standard Methods for the Examination of Water and Wastewater. Data of the TSS analysis are daily introduced by the Laboratory stuff (Administrative Analyst) into the form “Tab.1 Parámetros fisicoquímicos agua cruda”. The data are next revised and “published” in intranet by the Laboratory Chief (Professional of the Supporting Process). Data of the analysis are archived for 10 years in paper copy in folder no. 5 “Informes Análisis Línea de Agua WWTP-C” for each year. The Process Area has direct access to the data already “published” in intranet and is able to process them. The Process Area prepares monthly, semester and yearly reports of the functioning of the plant. Based on the most recent data of the years 2006 and 2007 of the Plant’s operation, the average concentration of TSS in influent wastewater entering WWTP-C was calculated.
Purpose of data	Calculation of emissions reduction
Additional comment	The calculation of the GHG emission reduction will be based on the direct measurement of the amount of methane captured and used as fuel in the engine of the electric generator or burned as emergency in the flares or water heater. Once the project is implemented, this parameter will not be necessary for the calculation.

Data/Parameter	GWP_{CH4}
Data unit	-
Description	Methane Global-Warming Potential
Source of data	Climate Change mitigation Climate Change 2014 – WGR Report AR5 -IPCC
Value(s) applied	21 for the first commitment period 25 for the second commitment period
Choice of data or measurement methods and procedures	-
Purpose of data	Calculation of baseline emission and project emission
Additional comment	-

Data/Parameter	D_{CH4}
Data unit	kg/Nm^3
Description	Methane Density
Source of data	Tool to determine project emissions from flaring gases containing methane Refer to UNFCCC Annex 13 Defined in the methodological tool EB-68 Annex 15 CDM UNFCCC – Table 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.7168
Choice of data or measurement methods and procedures	-
Purpose of data	Calculation of baseline emission and project emission
Additional comment	The value stated in the applied methodology is 0.7164 kg/Nm^3 and the value stated in the Methodological tool: Project emissions from flaring is 0.716 kg/Nm^3 The most conservative value will be used in each case (baseline and project emissions).

B.6.3. Ex ante calculation of emission reductions

Project activity emissions:

In accordance with approved monitoring methodology AMS III.H Methane recovery in wastewater treatment (Version 09, Scope 13, Mar 28, 2008), project activity emissions consist of:

$$PE_y = PE_{y,fugitive} = PE_{y,fugitive,s}$$

$$PE_{y,fugitive,s} = (1 - CFE_s) * MEP_{y,s,treatment} * GWP\_CH_4$$

Where:

CFE_s	Capture and utilization/combustion/flare efficiency of the methane recovery and combustion/utilization equipment in the sludge treatment (a default value of 0.9 was used, given no other appropriate value)
$MEP_{y,s,treatment}$	Methane emission potential of the sludge treatment system in year "y" (tons)
GWP_CH_4	Global Warming Potential for methane (value of 21 is used)

$$MEP_{y,s,treatment} = S_{y,untreated} * DOC_{y,s,untreated} * DOC_F * F * 16/12 * MCF_{s,treatment}$$

Where:

$S_{y,untreated}$	Amount of untreated sludge generated in the year "y" (tons)
$DOC_{y,s,untreated}$	Degradable organic content of the untreated sludge generated in the year y (fraction). It is estimated ex ante using the IPCC default values of 0.05 for domestic sludge (wet basis, considering a default dry matter content of 10 percent) or 0.09 for industrial sludge (wet basis, assuming dry matter content of 35 percent).

$MCF_{s,treatment}$	Methane correction factor for the sludge treatment system that will be equipped with methane recovery and combustion (MCF higher value of 1.0 as per table III.H.1 of the methodology III.H Methane recovery in wastewater treatment, Version 09, Scope 13, Mar 28, 2008).

Baseline emissions:

$$BE_y = MEP_{y,ww,treatment} * GWP\_CH4 + MEP_{y,s,treatment} * GWP\_CH_4$$

Where:

$MEP_{y,ww,treatment}$	Methane emission potential of wastewater treatment plant in year "y" (tons)
$MEP_{y,s,treatment}$	Methane emission potential of the sludge treatment system in year "y" (tons)
GWP_CH_4	Global Warming Potential for methane (value of 21 is used)

The characteristics of treated wastewater and its potential to generate methane are equal in the baseline and the proposed project activity. Treated wastewater quality and its potential to generate methane are alike in the baseline and the project activity. Therefore, the baseline emissions are going to be calculated as follows:

$$BE_y = MEP_{y,s,treatment} * GWP\_CH_4$$

Where:

$$MEP_{y,s,treatment} = S_{y,untreated} * DOC_{y,s,untreated} * DOCF * F * (16/12) * MCF_{s,treatment}$$

Where:

$S_{y,untreated}$	Amount of untreated sludge generated in year "y" (tons)
$DOC_{y,s,untreated}$	Degradable organic content of the untreated sludge generated in the year y (fraction). It is estimated ex ante using the IPCC default values of 0.05 for domestic sludge (wet basis, considering a default dry matter content of 10 %). This value was corrected by multiplying by the ratio between actual dry matter content (1.21%) and dry matter content of default value (10%).
DOCF	Fraction of DOC dissimilated to biogas (IPCC default value of 0.5)
F	Fraction of CH_4 in landfill gas (IPCC default of 0.5)
$MCF_{s,treatment}$	Methane correction factor for the sludge treatment system that will be equipped with methane recovery and combustion (MCF Lower value table III.H.1 of the methodology AMS III.H Methane recovery in wastewater treatment, Version 09, Scope 13, Mar 28,2008

Leakage due to the project activity:

Since the used technology does not involve equipment transferred from another activity and the existing equipment is not transferred to another activity, no leakage needs to be considered.

Project activity emission reductions:

$$ER_y = BE_y - PE_y – Leakage$$

Where:

BE_y	Baseline emissions in year “y” (tCO_2e)
PE_y	Project activity emissions in year “y” (tCO_2e)
Leakage	Not considered in further calculations

B.6.4. Summary of ex ante estimates of emission reductions

Year	Baseline emissions ($t CO_2e$)	Project emissions ($t CO_2e$)	Leakage ($t CO_2e$)	Emission reductions ($t CO_2e$)
2008	19,031	2,379	0	16,652
2009	60,380	7,547	0	52,832
2010	61,352	7,669	0	53,683
2011	62,024	7,753	0	54,271
2012	65,934	8,242	0	57,693
2013	66,937	8,367	0	58,570
2014	67,639	8,455	0	59,184
2015	67,739	8,467	0	59,272
2016	68,040	8,505	0	59,535
2017	68,210	8,526	0	59,634
2018	39,941	4,993	0	34,949
Total	**647,228**	**80,904**	0	**566,325**
Total number of crediting years	10 years			
Annual average over the crediting period	58,839	7,355	0	56,632

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data/Parameter	$fv_{CH4FG,h}$
Data unit	μV/V
Description	Volumetric fraction of methane in biogas fed into flares
Source of data	Continuous measuring meter with infrared. The measurement location is shown in Figure 5. Measurement Point 1
Value(s) applied	
Measurement methods and procedures	Type: Infrared methane concentration meter The data are captured from the sensor and recorded in the transmitter and SCADA System and the Data Table. Instrument Accuracy : ±5% Reading, ± 2 % a complete scale
Monitoring frequency	Continuously Monitored, hourly recording.

QA/QC procedures	Quality assurance: Given by the equipment manufacturer. Additionally, the monitoring of the flow meter is automatically computerized and supported by special software. The monitoring data are saved digitally in SCADA (Control and Acquisition Data System). Quality control: -Calibration: The instrument is calibrated regularly according to manufacturer's recommendations within one (1) year. - Maintenance: Routine maintenance of the instrument is performed. - The WWTP-C will undertake the statistical control of each parameter monitored and used for the calculation of the GHG emission reductions of a given CDM project.
Purpose of data	Calculation of project emissions
Additional comment	Recording Frequency: Continuously. Data record: Electronic for crediting period + 2 years

Data/Parameter	$FV_{RG,h}$
Data unit	Nm^3/h
Description	Volumetric flow rate of biogas fed into flares
Source of data	Volumetric Flow Meter principle of thermal dispersion with continuous measurement. The measurement location is shown in Figure 5. Measurement Point 2
Value(s) applied	The data may vary continuously
Measurement methods and procedures	The data are captured from a volumetric flow meter thermal and recorded in the SCADA System and the Data Table dispersion. Instrument Accuracy: ± 1% of reading ± 0.5% of complete scale
Monitoring frequency	Continuously monitored and hourly recording
QA/QC procedures	Quality assurance: Given by the equipment manufacturer. Additionally, the monitoring of the flow meter is automatically computerized and supported by special software. The monitoring data are saved digitally in SCADA (Control and Acquisition Data System) Quality control: -Calibration: The instrument is calibrated regularly in accordance with the manufacturer's recommendations no later than five (5) years. - Maintenance: Routine maintenance of the instrument is performed. - The WWTP-C will undertake the statistical control of each parameter monitored and used for the calculation of the GHG emission reductions of a given CDM project.
Purpose of data	Calculation of project emissions
Additional comment	Recording Frequency: Continuously. Data record: Electronic for crediting period + 2 years

Data/Parameter	T_{flare1}
Data unit	°C
Description	Temperature in the exhaust gas of the flares to determine combustion efficiency in flare 1
Source of data	Continuous temperature measurement meter by Thermocouple type K The measurement location is shown in Figure 5. Measurement Point 3
Value(s) applied	The data may vary continuously
Measurement methods and procedures	The data are captured from the sensor and recorded in the transmitter and SCADA System and the Data Table. Instrument Accuracy: ± 0.75% The operation hours of the flares are calculated taking into consideration a mínimum value of temperature.
Monitoring frequency	Continuously monitored and hourly recording

QA/QC procedures	Quality assurance: Given by the equipment manufacturer. Additionally, the monitoring of the flow meter is automatically computerized and supported by special software. The monitoring data are saved digitally in SCADA (Control and Acquisition Data System) Quality control: -Calibration: The instrument is calibrated regularly in accordance with the manufacturer's recommendations or every year. - Maintenance: Routine maintenance of the instrument is performed.
Purpose of data	This parameter is used to determine the efficiency in reducing methane in the flares.
Additional comment	Recording Frequency: Continuously. Data record: Electronic for crediting period + 2 years

Data/Parameter	T_{flare2}
Data unit	°C
Description	Temperature in the exhaust gas of the flare required to determine the combustion efficiency in flare 2
Source of data	Measured. Continuous temperature measurement meter by Thermocouple type KThe measurement location is shown in Figure 5. Measurement Point 4
Value(s) applied	The data may vary continuously
Measurement methods and procedures	The data are captured from the sensor and recorded in the transmitter and SCADA System and the Data Table. Instrument Accuracy: ± 0.75% The operation hours of the flares are calculated taking into consideration a mínimum value of temperature.
Monitoring frequency	Continuously monitored and hourly recording
QA/QC procedures	Quality assurance: Given by the equipment manufacturer. Additionally, the monitoring of the flow meter is automatically computerized and supported by special software. The monitoring data are saved digitally in SCADA (Control and Acquisition Data System) Quality control: -Calibration: The instrument is calibrated regularly in accordance with the manufacturer's recommendations every year. - Maintenance: Routine maintenance of the instrument is performed.
Purpose of data	This parameter is used to determine the efficiency in reducing methane in the flares.
Additional comment	

Data/Parameter	$FV_{G1,h}$
Data unit	Nm^3/h
Description	Volumetric flow rate of biogas fed into the electric generator engine 1
Source of data	Volumetric Flow Meter principle of thermal dispersion with continuous measurement. The measurement location is shown in Figure 5. Measurement Point 5.
Value(s) applied	The data may vary continuously
Measurement methods and procedures	The data are captured from a volumetric flow meter thermal and recorded in the SCADA System and the Data Table. Instrument Accuracy: ± 1% of reading ± 0.5% of full scale This value is used for the calculation of the operation hours of the water heaters.
Monitoring frequency	Continuously monitored and hourly recording

QA/QC procedures	Quality assurance: Given by the equipment manufacturer. Additionally, the monitoring of the flow meter is automatically computerized and supported by special software. The monitoring data are saved digitally in SCADA (Control and Acquisition Data System) Quality control: -Calibration: The instrument is calibrated regularly in accordance with the manufacturer's recommendations no later than five (5) years. - Maintenance: Routine maintenance of the instrument is performed. - the WWTP-C will undertake the statistical control of each parameter monitored and used for the calculation of the GHG emission reductions of a given CDM project.
Purpose of data	Calculation of project emissions
Additional comment	Recording Frequency: Continuously. Data record: Electronic for crediting period + 2 years

Data/Parameter	$FV_{G2,h}$
Data unit	Nm^3/h
Description	Volumetric flow rate of biogas fed into the electric generator engine 2
Source of data	Volumetric Meter principle of thermal dispersion with continuous measurement. The measurement location is shown in Figure 5. Measurement Point 6
Value(s) applied	The data may vary continuously
Measurement methods and procedures	The data are captured from a flow meter thermal and recorded in the SCADA System and the Data Table dispersion. Instrument Accuracy: ± 1% of reading ± 0.5% of complete scale This value is used for the calculation of the operation hours of the water heaters
Monitoring frequency	Continuosly monitored and hourly recording
QA/QC procedures	Quality assurance: Given by the equipment manufacturer. Additionally, the monitoring of the flow meter is automatically computerized and supported by special software. The monitoring data are saved digitally in SCADA (Control and Acquisition Data System) Quality control: -Calibration: The instrument is calibrated regularly in accordance with the manufacturer's recommendations no later than five (5) years. - Maintenance: Routine maintenance of the instrument is performed. - the WWTP-C will undertake the statistical control of each parameter monitored and used for the calculation of the GHG emission reductions of a given CDM project.
Purpose of data	Calculation of project emissions.
Additional comment	Recording Frequency: Continuously. Data record: Electronic for crediting period + 2 years

Data/Parameter	$FV_{H,h}$
Data unit	Nm^3/h
Description	Volumetric flow rate of biogas fed into the water heater
Source of data	Volumetric Flow Meter principle of thermal dispersion with continuous measurement. The measurement location is shown in Figure 5. Measurement Point 7
Value(s) applied	
Measurement methods and procedures	The data are captured from a volumetric flow meter thermal and recorded in the SCADA System and the Data Table. Instrument Accuracy: ± 1% of reading ± 0.5% of complete scale
Monitoring frequency	Continuously monitored and hourly recording

QA/QC procedures	Quality assurance: Given by the equipment manufacturer. Additionally, the monitoring of the flow meter is automatically computerized and supported by special software. The monitoring data are saved digitally in SCADA (Control and Acquisition Data System) Quality control: -Calibration: The instrument is calibrated regularly in accordance with the manufacturer's recommendations no later than five (5) years. - Maintenance: Routine maintenance of the instrument is performed. - the WWTP-C will undertake the statistical control of each parameter monitored and used for the calculation of the GHG emission reductions of a given CDM project.
Purpose of data	Calculation of project emissions
Additional comment	Recording Frequency: Continuously. Data record: Electronic for crediting period + 2 years

Data/Parameter	$fv_{CH4\ H,h}$
Data unit	μV/V
Description	Volumetric fraction of methane in biogas combusted in water heater
Source of data	Continuous measuring meter with infrared. The measurement location is shown in Figure 5. Measurement Point 8
Value(s) applied	
Measurement methods and procedures	
Monitoring frequency	The data are captured from the sensor and recorded in the transmitter and SCADA System and the Data Table. Instrument Accuracy : ± 5% of reading ± 2% of complete scale
QA/QC procedures	Quality assurance: Given by the equipment manufacturer. Additionally, the monitoring of the flow meter is automatically computerized and supported by special software. The monitoring data are saved digitally in SCADA (Control and Acquisition Data System) Quality control: -Calibration: The instrument is calibrated regularly in accordance with the manufacturer's recommendations within one (1) year. - Maintenance: Routine maintenance of the instrument is performed. - the WWTP-C will undertake the statistical control of each parameter monitored and used for the calculation of the GHG emission reductions of a given CDM project.
Purpose of data	Calculation of project emissions
Additional comment	Recording Frequency: Continuously. Data record: Electronic for crediting period + 2 years

Data/Parameter	fv_{CH4}, G,h
Data unit	μV/V
Description	Volumetric fraction of methane in biogas fed into the electric generator engine
Source of data	Continuous measuring meter with infrared. The measurement location is shown in Figure 5. Measurement Point 9
Value(s) applied	
Measurement methods and procedures	The data are captured from the sensor and recorded in the transmitter and SCADA System and the Data Table. Instrument Accuracy : ± 5% of reading ± 2% of complete scale
Monitoring frequency	Continuously monitored and hourly recording

QA/QC procedures	Quality assurance: Given by the equipment manufacturer. Additionally, the monitoring of the flow meter is automatically computerized and supported by special software. The monitoring data are saved digitally in SCADA (Control and Acquisition Data System) Quality control: -Calibration: The instrument is calibrated regularly in accordance with the manufacturer's recommendations. - Maintenance: Routine maintenance of the instrument is performed. - the WWTP-C will undertake the statistical control of each parameter monitored and used for the calculation of the GHG emission reductions of a given CDM project.
Purpose of data	Calculation of project emissions.
Additional comment	Recording Frequency: Continuously. Data record: Electronic for crediting period + 2 years

Data/Parameter	η_{flare}
Data unit	%
Description	Flare efficiency
Source of data	Continuous calculated from the temperature of the flares
Value(s) applied	90%
Measurement methods and procedures	The following option will be used to determine the efficiency of the flaring process in an enclosed flare: to adopt a 90% default value. In case of enclosed flares and use of the default value for the flare efficiency (90%), the flare efficiency in the hour h ($\eta_{flare,h}$) is: • 0% if the temperature in the exhaust gas of the flare (T_{flare}) is below 500°C for more than 20 minutes during the hour h • 50% if the temperature in the exhaust gas of the flare (T_{flare}) is above 500°C for more than 40 minutes during the hour h, but the manufacturer's specifications on proper operation of the flare are not met at any point in the time during the hour h • 90% if the temperature in the exhaust gas of the flare (T_{flare}) is above 500°C for more than 40 minutes during the hour h and the manufacturer's specifications on proper operation of the flare are met continuously during the hour h.
Monitoring frequency	Continuously monitored and hourly recording
QA/QC procedures	Not applicable
Purpose of data	Calculation of baseline emission and Project emission.
Additional comment	Recording Frequency: hourly. Data record: Electronic for crediting period + 2 years

Data/Parameter	ECy
Data unit	MWh
Description	Grid electricity consumption in year "y"
Source of data	Monitoring consists in determining energy consumption data of all equipment/devices (booster of flares and water heater) used in the project activity wastewater and sludge treatment systems and systems for biogas recovery and flaring, using the number of operational hours.
Value(s) applied	

Measurement methods and procedures	The method to determine the operation of the operational hours of the flare 1 and flare 2 that consumes electricity would be: • $Op_{flare1\ and\ 2}$=0 when temperature in the exhaust gas of the flares required to determine the combustion efficiency in flare 1 and 2 is below 500ºC. • $Op_{flare1\ and\ 2}$=1 when temperature in the exhaust gas of the flares required to determine the combustion efficiency in flare 1 and 2 is higher than 500ºC The method to determine the operation of the operational hours of the water heater that consumes electricity would be: • $Op_{water\ heater}$=0 when the volumetric flow of biogas fed into the water heater is zero. • $Op_{water\ heater}$=1 when the volumetric flow of biogas fed into the water heater is above zero. Once determined the operational hours of the equipment, the nameplate capacity of the equipment is multiplied by the operational hours to determine the electricity consumption.
Monitoring frequency	Continuously monitored and hourly recording
QA/QC procedures	
Purpose of data	Calculation of project emissions from electricity consumption in the year y (t CO2e)
Additional comment	Under normal operational conditions, the plant uses the generated electricity produced by biogas. In order to be conservative the calculations of project emissions are conducted considering that the flares and the water heater are operating using 100% electricity from the national grid.

Data/Parameter	EF
Data unit	tCO_2/MWh
Description	Grid emission factor
Source of data	Grid emission factor of the National interconnected System calculated in accordance with AMS-I.D or using data published by UPME (Energy and Mining Unit of Colombia) for the relevant year.
Value(s) applied	
Measurement methods and procedures	Not applicable
Monitoring frequency	The value will be calculated for the year in which the electricity consumption occurs.
QA/QC procedures	Not applicable
Purpose of data	Calculation of project emissions in case that electricity consumption is produced in the plant.
Additional comment	Data record: Electronic for crediting period + 2 years

B.7.2. Sampling plan

Not applicable

B.7.3. Other elements of monitoring plan

Alternate operation of the flares and water heater

Under regular conditions, all biogas is burnt in the electric generation system. In case of its failure or in case of the excess of biogas, it will be redirected to the enclosed flares and combusted. The WWTP-C had foreseen two emergency flares of 550 m^3/h of biogas flow. In case of the failure of one of them, the other can take-up the task as each of them can operate with any of the storage tanks.

In such case default value of combustion efficiency of 90% will be adopted for the calculations of the GHG emissions, according to the methodology AMS III.H Methane recovery in wastewater treatment (Version 09, Scope 13, Mar 28, 2008). Please see the description above.

Under regular conditions, water from the cooling of the generator's motors is used for the maintenance of the temperature of digesters (between 33 to 35°C). In case of the failure of the generation system, where in regular operation of the WWTP-C biogas is being burnt, some of the biogas will be redirected and combusted in water heater in order to maintain the regular operation of the anaerobic digesters, and the rest will be burned in the flares.

Enclosed flares

In order to determine project emissions from flaring methane, the 7 step approach of the methodological "Tool to determine project emissions from flaring gases containing methane" was fallowed. Conform to the above mentioned tool the efficiency for the enclosed flares is taken as default (90%).

Step 1: Determination of the mass flow rate of the residual gas (biogas) that is flared

$FM_{RG,h} = \rho_{RG,n,h} * FV_{RG,h}$

Where:

$FM_{RG,h}$ mass flow rate of biogas in hour h (kg/h)
$P_{RG,n,h}$ density of biogas at normal conditions in hour h (kg/m^3)
$FV_{RG,h}$ Volumetric flow rate of biogas at normal conditions in the hour h (Nm^3/h)

Step 2: Determination of the mass fraction of carbon, hydrogen, oxygen and nitrogen in the residual gas (biogas).

This step is not necessary as the parameters to be estimated are further used only in steps 3 and 4 that apply exclusively for the continuous measurement of the flare efficiency.

Step 3: Determination of the volumetric flow rate of the exhaust gas on a dry basis This step does not apply, as the flare efficiency is not monitored continuously.

Step 4: Determination of methane mass flow rate in the exhaust gas on a dry basis This step does not apply, as the flare efficiency is not monitored continuously.

Step 5: Determination of methane mass flow rate in the residual gas (biogas) on a dry basis

$$TM_{RG,h} = FV_{RG,n,h} * \int FV_{CH4,RG,h} * P_{ch4,n}$$

Where:

$TM_{RG,h}$ mass flow rate of methane in biogas in the hour h (kg/h)
$FV_{RG,n,h}$ volumetric flow rate of biogas in dry basis at normal conditions in the hour h (m^3/h)
$\int FV_{CH4,RG,h}$ volumetric fraction of methane in biogas on dry basis in hour h (--)

$P_{ch4,n}$ density of methane at normal conditions (0.716 kg/m3)

As the two measurements of the volumetric fraction of methane in biogas and volumetric biogas flow rate are conducted in wet basis and the measurements points are located in a very small distance from each other (measuring points 1 and 2 of the Figure 6), it is concluded that the sample of biogas has the same parameters with respect to the humidity rate, temperature and pressure. Therefore, these two parameters of volumetric flow rate of biogas and volumetric fraction of methane in this biogas are not brought to the dry basis as it is not necessary.

The data will be recorded by the Control and Acquisition Data System - SCADA. For the description of the system please refer to the description given below.

Step 6: Determination of the hourly flare efficiency.

The methodology AMS III.H Methane recovery in wastewater treatment (Version 09, Scope 13, Mar 28, 2008), indicates that the flare efficiency, defined as the fraction of time in which the gas is combusted in flare, multiplied by the efficiency of the flaring process, shall be monitored. One of the two following options shall be used to determine the efficiency of the flaring process in an enclosed flare:

a. To adopt a 90% default value, or
b. To perform a continuous monitoring of the efficiency.

According to the methodological “Tool to determine project emissions from flaring gases containing methane”, in case of enclosed flares and use of the default value for the flare efficiency (90%), the flare efficiency in the hour h ($\eta_{flare,h}$) is:

- 0% if the temperature in the exhaust gas of the flare (Tflare) is below 500°C for more than 20 minutes during the hour h
- 50% if the temperature in the exhaust gas of the flare (Tflare) is above 500°C for more than 40 minutes during the hour h, but the manufacturer’s specifications on proper operation of the flare are not met at any point in the time during the hour h
- 90% if the temperature in the exhaust gas of the flare (Tflare) is above 500°C for more than 40 minutes during the hour h and the manufacturer’s specifications on proper operation of the flare are met continuously during the hour h.

The operation time of the flares will be measured and recorded automatically by the Control and Acquisition Data System – SCADA as well as all the other parameters monitored (temperature – measuring points 3 and 4 of the Figure 6 and volumetric biogas flow rate – measurement point 2 of the Figure 6). Please see the maintenance description of the meters in section B.7.1 and their localization in present section, Figure 6. Please see the description of SCADA below.

Step 7: Calculation of annual project emissions from flaring

$$PEflare,y = \sum_{h-1}^{8760} TMRG,h \times (1 - \mu flare,h) \times \frac{GWPCH4}{1000}$$

$PE_{flare,y}$ project emissions from flaring of the biogas stream in year y (tCO_2e)
$TM_{RG,h}$ mass flow rate of methane in the residual gas in the hour h (kg/h)
$\eta_{flare,h}$ flare efficiency in hour h (--)

Electric generators engines

To estimate the amount of methane fuelled into the electric generator´s engines, the following equation is used:

$$TM_{G,h}=FV_{G,h} * fv_{CH4,G,h} * P_{CH4,n}$$

$TM_{G,h}$	mass flow rate of methane in biogas fuelled into the electric generator engines in the hour h (kg/h)
$FV_{G,h}$	volumetric flow of biogas fed into electric generator's engines at normal conditions in hour h (m^3/h)
$fv_{CH4,G,h}$	volumetric fraction of methane in biogas fed to the electric generator in hour h (µV/V)
$P_{CH4,n}$	methane density at normal conditions (0.716 kg/m^3)

Electricity consumption

In regular operation biogas will be combusted in the engines of the electric generators, which does not require an outside input of the electric energy (from the grid) and neither does the gas dehumidificator nor gas storage tanks.

Under the alternate operation conditions, when the biogas might be combusted in the flares or the water heater, the only electricity consumption might occur during the operation of the flares and such will be monitored and subtracted from the total emission reductions achieved by the project activity.,.

Leakage

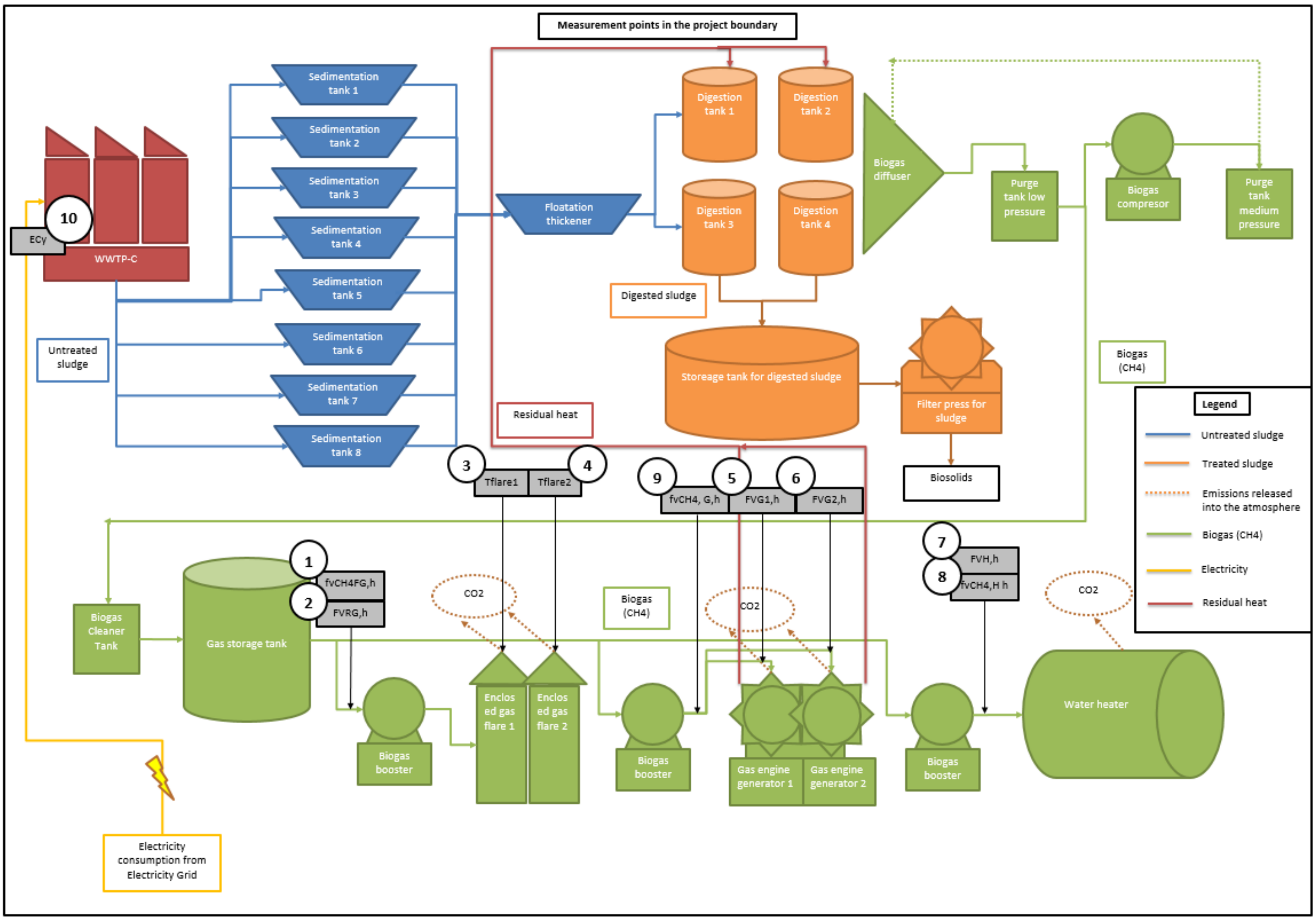
The only leakages considered by the Methodology AMS III.H Methane recovery in wastewater treatment (Version 09, Scope 13, Mar 28, 2008), are those related to the case when capture and flare equipment are supplied from another activity, or if existing equipment were transferred to another activity. None of these cases takes place in the project activity proposed nor is feasible to change this situation in the forthcoming time, and consequently it is not necessary to monitor leakages.

Parameters monitored

The following figure presents a general overview of the monitoring plan with the indication of the location of the parameters monitored:

1	$fv_{CH4,FG,h}$:	Average volumetric fraction of methane in biogas (µV/V) combusted in flares (µV/V)
2	$FV_{RG,h}$:	Volumetric biogas flow rate carried for combustion in the flare (m^3/h)
3 and 4	T_{flare}	Temperature in the exhaust gas of the flares (°C)
5 and 6	$FV_{G,h}$:	Volumetric biogas flow rate carried to the engines of the electric generators (m^3/h)
7	$FV_{H,h}$	Volumetric biogas flow rate carried for combustion in water heater (m^3/h)
8	$fv_{CH4,H,h}$:	Average volumetric fraction of methane in biogas combusted in water heater (µV/V)
9	$fv_{CH4,G,h}$:	Average volumetric fraction of methane in biogas fed into the engines of the electric generators (µV/V)
10	EC_y	Grid electricity consumption in year "y" (MWh)
11	EF	Grid Emission Factor (tCO_2/MWh)

Figure 5: Monitoring Plan graph



Descriptions of the operation and maintenance of the control and acquisition data System – SCADA

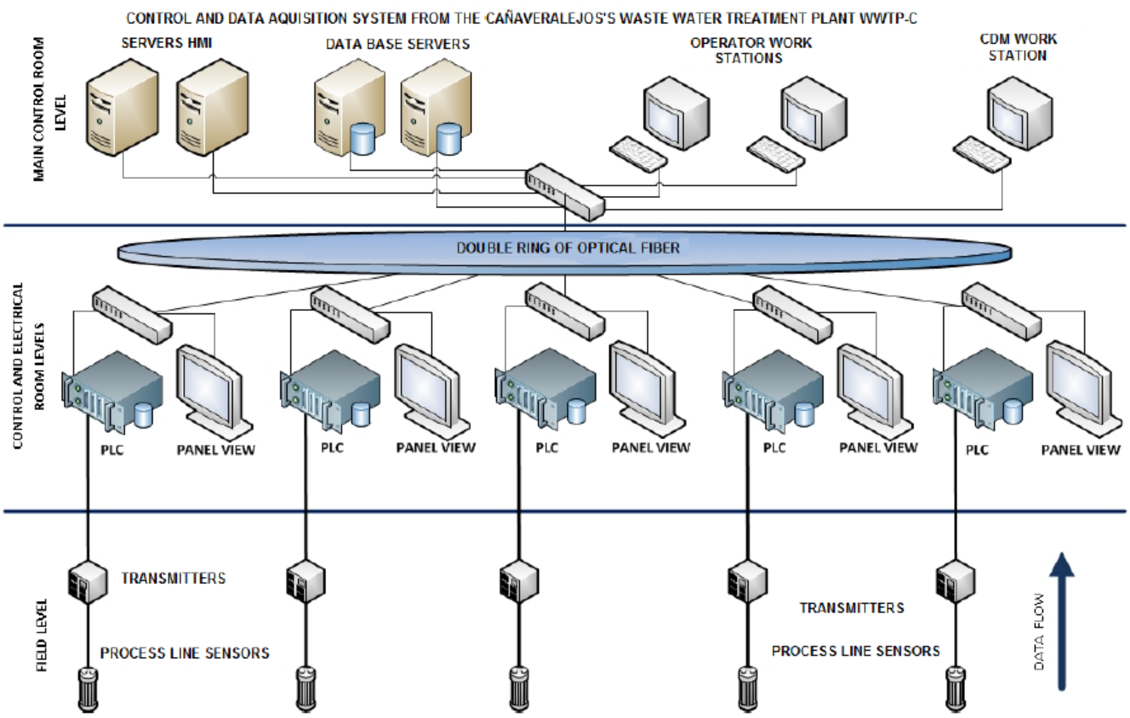
SCADA stability is offered by having redundancy from the level of electrical and control rooms. From this level redundancy is manifested by the double fiber optic ring which goes through the plant communicating PLC's and workstations so that they work as a system. The panel views installed in each electrical room allow control of the entire plant becoming redundant one of the others.

In the main control room the redundancy in HMI (Human Machine Interface) servers and redundancy in the database servers. In case one of the servers failure the other assumes the workload automatically. Once the server resets this fault automatically synchronizes again with the one in service and continues its normal operation. This applies to both applications HMI (Human Machine Interface) servers as the database server. Each server has inside an array of RAID 5 Array (HDD) hard drives which also allow replacement of hard drives. Each server has a dual power supply.

As for the security of SCADA the HMI (Human Machine Interface) application can be accessed only by entering specified username and password for each operator. This application offers various levels of access according to user profiles.

User activity in in the system is recorded by an event registration. For databases and registered data themselves we must say that the ORACLE database can only be accessed with username and password. The data is written to the database only by the HMI (Human Machine Interface) application automatically and by the Microsoft Excel program. These have an encrypted code in their user name and password that allows them to fulfil their function. Users access to these programs, as mentioned above, entering a username and password.

Figure 6. Data control system of WWPT-Cañaveralejo



The Parameters to be collected by the SCADA system, are as follows:

Table 2: Parameters collected by SCADA

Parameter	Unit	Frequency of the collection of data

$fv_{,CH4,G,h}$ $fv_{CH4,FG,h}$ $fv_{,CH4,H,h}$	Volumetric fraction of methane in biogas fed into the engines of the electric generators or combusted in flares and/or water heater	µV/V	Continuous
$FV_{G,h}$ $FV_{RG,h}$ $FV_{H,h}$	Volumetric flow rate of biogas fed into the engines of the electric generators, flared and/or combusted in water heater	Nm^3/h biogas	Continuous
T_{flare}	Temperature of the exhaust gas of the flares	°C	Continuous

Maintenance of the engines of the electric generator, flares, water heater, dehumidifier and biogas storage tanks.

To ensure the proper functioning of given equipment the WWTP-C undertakes the following activities:

- Preventive maintenance: the WWTP-C undertakes routine/preventive maintenance (according to the activities planned with anticipation) depending on the type of the equipment, the specifications of the manufacturer and the functioning of the equipment itself.

- Corrective maintenance: in case of the failure of a given device, Control and Acquisition Data System – SCADA sends an automatic signal, which initiates the corrective procedure foreseen for each type of the device and based on the type of the fault presented. Corrective actions will be undergone by the WWTP-C staff or external, expert entity (depending on the type of the equipment and the fault presented).

Moreover,

a) in case of the failure of the electric engines-generator system, the WWTP-C counts with the complete redundant stand by system of additional engines-generator set with its proper auxiliary skid, which enables its immediate operation when it is necessary. Moreover, each set of the engines-generator consist of the complementary equipment that has its stand-by redundant replacement that additionally, in case of a failure, can work for any of the set of engines-generator. The auxiliary and complementary equipment is included in the plan of the routine/preventive activities undertaken by the WWTP-C staff (see preventive maintenance described above),

b) in case of the failure of the flare, the WWTP-C counts with a second one that can operate with any of the biogas storage tanks,

c) the water heater enters into operation only in abnormal conditions when any of the two sets of engines-generator is not functioning. In case of the failure of the heater, the WWTP-C staff or an external expert entity will undertake necessary corrective actions meanwhile the biogas is burnt in flares.

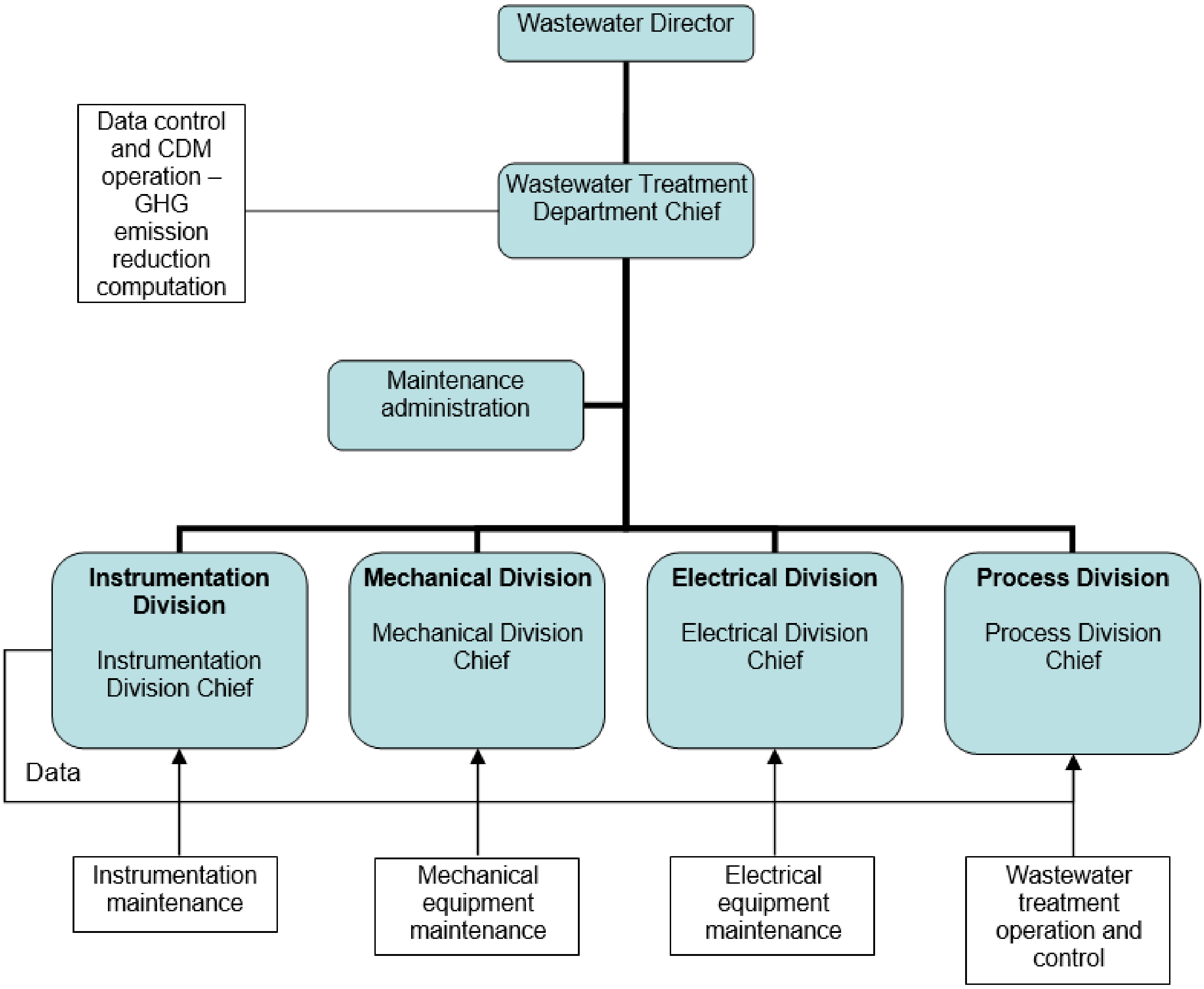
All the evidence of the maintenance undertaken by the WWTP-C staff will be stored in the maintenance software by the Administrator of Maintenance for at least 10+2 years in a magnetic mode. The copies will be stored in a paper mode by the respective chief of the WWTP-C Area in charge for at least 10+2 years.

All the evidence (with its respective copies) of the maintenance undertaken by the external entity will be stored with respective copy in a paper mode by the respective chief of the WWTP-C Area in charge for at least 10+2 years.

Responsibilities of Areas of the WWTP-C

The following figure presents the flow of information between the afore mentioned areas and responsibilities of each of them.

Figure 7: Management structure of Monitoring & Verification Plan (MVP)



The monitoring and verification plan (MVP) participants are accountable for the following:

1.1 Director of Wastewater

Direction of WWTP- Cañaveralejo is responsible for:

Administrative direction and monitoring of the CDM projects activities and the monitoring plan of WWTP – Cañaveralejo of EMCALI.

The WWTP-C direction assigned to the Chief of Department of Treatment as support and technical support for the following activities:

- Administrative direction and supervision of the preparation and delivery of reports related to the performance of the monitoring plan and results of GHG emission reduction CDM project of WWTP-C.

- Annual review of performance monitoring plan and approval of changes from the monitoring plan in case they are required.

- Approval of the annual calculations of GHG reductions made by the Maintenance management Division.

1.2 Instrumentation Division

Instrumentation division is responsible for:

- Maintenance of control and instrumentation equipment of the WWTP-C, including the maintenance of the Supervisory Control and Data Acquisition – SCADA.

- Preparation of the annual program of preventive and corrective maintenance of the WWTPC instruments

- Preparation of a weekly schedule of preventive and corrective maintenance of the WWTP-C instruments

- Review and approval of work orders by the Chief of instrumentation Division

- Archives of work orders for a period of 10 +2 years in instrumentation office.

- Supervision and control of the operation of the data servers, as well as monitoring and supervision of the maintenance activities SCADA hired through an outsourced service.

1.3 Process Division

The process division is responsible for the following activities:

- Preparation of monthly reports of the results of the plant operations.

- Operate and control the process of the Wastewater treatment.

With regard to the CDM management projects WWTP-C, the WWTP-C direction assigned to the Maintenance Management Division as support and technical support in activities control, monitoring and calculations results of the CDM project activity.

The Maintenance Management Division is responsible for: - Computation of GHG emissions reduction of the two CDM projects and presentation to the WWTP-C direction for approval. - Storage and control of computation and the results of GHG emission reductions of CDM projects in the servers' database from the control system located in the control room of the WWTP-C for a period of 10 + 2 years on magnetic media. - Control and monitoring of statistical techniques and management trends applied to the variables of the monitoring plan of the two CDM projects.

1.4 Mechanical Division

The Mechanical Division is responsible for the following:

- General maintenance of mechanical equipment of WWTP-Cañaveralejo.

- Preparation of the annual program of WWTP-C mechanical equipment maintenance.

- Preparation of a weekly schedule of WWTP-C mechanical equipment maintenance.

- Review and approval of work orders by the mechanical division chief and subsequent delivery of orders to the maintenance management division.

- Archives of work orders for a period of 10 +2 years in instrumentation office.

1.5 Electrical Division

Electrical division is responsible for the following:

- General maintenance of the plant electrical equipment (preventive, corrective and predictive).

- Generators operation and maintenance.

- Preparation of the annual WWTP-C program electrical equipment maintenance.

- Preparation of a weekly schedule of the WWTP-C electrical equipment maintenance.

- Review and approval of work orders by the Electrical division chief and subsequent delivery of maintenance orders of maintenance management division.

- Archives of work orders for a period of 10 +2 years in the electrical division office.

Training procedure of the WWTP-C staff

The procedure for the training of the personal of the WWTP-C with respect to the operation, maintenance, calibration and monitoring of equipment under the project activity is the following:

The provider in person of the technical expert who installs or delivers to the WWTP-C any system, equipment, instrument, etc., has the responsibility to adequately train the staff of the WWTP-C or a representative group with respect to its operation and/or maintenance. Training is considered adequate when the trained personal shows sufficient skills for the operation and/or maintenance of the equipment or system received.

When it is considered convenient, a heterogeneous group from among all the personal that requires training is being selected by the Chief of each of the Plant's Area taking into consideration their skills, level of responsibility and education as well as the participation in the process. This group compromise themselves to convey the information received during the training to the rest of the respective personal of the Plant. The evidence of the training received by the personal in question

is being archived by the Chief of each respective Area (please see the respective forms in the Annex 4 to the present document).

The monitoring of the performance of the equipment itself as well as the personal that interacts with them is being performed with the purpose to indicate whether the works conduct by the technical personal is sufficient and adequate to the training given and whether any further training of such personal is required. The assessment is being undergone by the Chief of each Area based on the outcome of the corrective and preventive maintenance orders (Ordenes del trabajo).

Continuous improvement in the monitoring of the CDM project activity

The WWTP-C will ensure continuous improvement of the Monitoring Plan of the CDM project activity by the execution of the following activities:

- Control and evaluation of the performance of the WWTP-C staff involved in the monitoring plan of the CDM project.

The evaluation of the WWTP-C staff is undergone by the chief of each Area to which an evaluated person belongs (process, mechanical, instrumental), based on the “maintenance orders” that each responsible person has the obligation to fill in when executing the preventive and corrective maintenance activity. Based on this evaluation it is concluded whether a given person does his duties well or any additional training is necessary to improve his skills. For more information please refer to the point above “TRAINING PROCEDURE OF THE WWTP-C STAFF”.

- Periodical revision of the Monitoring Plan by the chief of Treatment Department and finally reviewed and approved by the Director of the WWTP-C.

The evaluation of the Monitoring Plan will be undergone every year by the Director of the WWTP-C with the purpose to assess any changes to the Plan or necessity for its future improvement. The outcome of such evaluation with the eventual changes or decisions for the improvements will be stored by the Director of the WWTP-C and available for the annual verification.

- Quality control of the parameters monitored within the CDM project activity

The WWTP-C has foreseen procedures for the control of the monitored parameters by means of 1) continuous data analysis undergone by the chief of each responsible Area and 2) by the control of the performance of the CDM project equipment and project monitoring instrumentation. The first is undergone by the statistical control of the monitoring parameters and the second by the execution of the preventive and corrective maintenance activities and, in case of the monitoring equipment, the periodical calibration. For more information with respect to the activities above mentioned as well as the storage and back up of the monitoring data and other documents related to the CDM project operation, please refer to the section B.7.1 and B.7.2 of the present document.

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

31/03/2002

C.2. Expected operational lifetime of project activity

25 years 00 months

C.3. Crediting period of project activity
C.3.1. Type of crediting period

Fixed

C.3.2. Start date of crediting period

01/08/2008

C.3.3. Duration of crediting period

10 years 00 months

SECTION D. Environmental impacts
D.1. Analysis of environmental impacts

PricewaterhouseCoopers Ltda., as an independent and advisory entity for the development of this CDM project, evaluated in October 2006 the positive and negative environmental, social and technological impacts of the proposed project activity of biogas capture and combustion in the installations of the WWTP-C. The outcome of the study is presented in Table 5 below. For its implementation purposes the Gold Standard criteria, tailored to the project of biogas capture and high efficiency combustion, were followed.

In conclusion, project participants do not consider that the activity of the proposed CDM project generate significant direct neither transboundary negative environmental impacts.

Evaluation of sustainable development of the proposed project activity

Storing system:

- -2: major negative impacts, i.e. where there is significant damage to ecological, social and/or economic systems that cannot be mitigated through preventive (not remedial) measures.
- -1: minor negative impacts, i.e. where there is a measurable impact but not one that is considered by stakeholders to mitigate against the implementation of the project activity or cause significant damage to ecological, social and/or economic systems.
- 0: no, or negligible impacts, i.e. there is no impact or the impact is considered insignificant by stakeholders.
- +1: minor positive impacts
- +2: major positive impacts

Table 3: Assessment matrix of the sustainable performance of the project's activity

Component indicators	Impact description	Score (-2 to 2)
Local/regional/global environment		
Water quality and quantity	The project's activity does not use hydro-sources.	0
Air quality (additional emissions to GHG)	Taking into consideration that biogas is mainly composed of: ➢ methane, carbon dioxide and oxygen (in total 89%, according to the analysis of biogas generated in the WWTP-C of 8 and 15 of May 2006 – see the table below), which during the combustion decompose to the	-1

substances: water vapor and carbon dioxide (methane decompose in a following manner: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$),

	Digester B	Digester C	Digester E	Average
	%	%	%	%
CO_2	27.60	27.20	26.40	27.07
CH_4	64.20	60.30	56.80	60.43
O_2	0.50	2.30	3.00	1.93
Total	92.30	89.80	86.20	**89.43**

and

- traces of hydrogen, nitrogen and H_2S (in total 11%) that are considered negligible,

at the time of the preparation of the PDD, the emissions of SO_x, NO_x and particulate matter (PM) resulting from the biogas combustion in the internal combustion engine of the electric generator and/or in enclosed biogas flares were estimated, but were not considered to have adverse impact on the environment. Please see the text below.

For the emissions resulting from the biogas combustion, such as SO_x, NO_x or PM, below we present:

- reference values of these emissions from the enclosed biogas flares from the study conducted by UK Environmental Agency[29] and

- calculation that was conducted for the rough estimations of the possible emissions of these substances resulting from the biogas combustion in the internal combustion engine of the electric generator based on the emission factor of Danish National Environmental Research Institute[30].

<u>Enclosed biogas flares emissions</u>

According to the set of measurements of emissions resulting from flaring biogas (landfill gas) in enclosed flares conducted by the UK Environmental Agency, mean values of NO_x and PM emissions are below the international standards set for landfill gas flare emissions. The estimation of emissions of SO_x in the WWTP-C (as calculated below under point 1) is also considered to be below these standards:

	Mean values (mg/m^3)	Emission Standards (mg/m^3)				
		Germany proposed	Germany 2001	Switzerland	Belgium	England, Wales & Scotland
NO_x	62.3	200	200	80	150	150
PM	5.47	10	--	10	5	--
SO_2	28.57 (Based on the calculation for specific case of the WWTP-C below)	--	--	50	35	--

* Emission standards were taken from the table 4.1, Chapter: "Review of emission standards and legislation" and mean values for NO_x and PM from table A2, Appendix A, of Guidance for monitoring enclosed landfill gas flares. UK Environmental Agency, September 2004.

** The values of SO_2 were calculated based on the amount of H_2S present in input fuel (biogas) – see the calculation below.

Internal Combustion Engine of the Electric Generator

1. Calculation of the amount of SO_x emitted (expressed as SO_2, as combustion converts H_2S into water vapor and sulphur dioxide - SO_2) based on the maximum amount of H_2S present in biogas input. (According to the biogas purifier technical specifications, the amount of H_2S present in biogas is being reduced to the value of 10ppm maximum.

$$Concentración_{H2S}\left[\frac{mg}{m^3_{biogas}}\right] = \frac{Concentración_{H2S}\,[ppm] x\ Molecular\ Weight_{H2S}\,[\frac{g}{mole}]}{Molecular\ Volume\ x\ 10^3\,[\frac{m^3}{mole}]}$$

* Conversion to the standard units of mg/m3, at a base temperature of 273K and 101.3 kPa.

Conversion of H_2S during its combustion to water vapor and sulphur dioxide occurs according to the following equation:

$$H_2S + \frac{3}{2}\,O_2 = SO_2 + H_2O$$

To calculate the amount of SO_2 generated from 15.18 mg of H_2S, the following equation is applied:

$$\frac{15.18\ mg_{H2S}}{1\ m^3_{biogas}}\ x\ \frac{1mmol_{H2S}}{1mmol_{H2S}}\ x\ \frac{1mmol_{SO2}}{1mmol_{H2S}}\ x\ \frac{64mg_{SO2}}{1mmol_{SO2}} = \frac{15.18\ x\ 64\ mg_{SO2}}{34m^3_{biogas}} = 28.57\ \frac{mg_{SO2}}{m^3_{biogas}}$$

The amount generated equals to 28.57 mg_{SO2}/m^3_{biogas}.

Knowing that:

- the volume of the input gas (biogas) is lower than the output gas (exhaust gas) (due to the addition of the air into the combustion process) $V_{input\ gas} < V_{output\ gas}$

- and so is the concentration of this pollutant per $1m^3$ of the input gas in comparison with its concentration in the exhaust gas, therefore, the value of 28.57 mg_{SO2}/m^3_{biogas}[vi] will be lower if expressed in $mg_{SO2}/m^3_{exhaust\ gas}$, as the existing international standards below are expressed:

- German standard TA Luft 2002: the combustion of biogas (landfill gas) in the internal combustion engine – limit set for SOx - 350 $mg/m^3_{exhaust\ gas}$[vii];

- Swiss LRV standard: the combustion of biogas (landfill gas) in the stationary combustion engine — the limits for SO_x are not set.

Conclusion: The estimated amount of 28.57 mg_{SO2}/m^3_{biogas} emitted during the biogas combustion in the internal combustion engine of the electric

	generator in the WWTP-C is considered negligible in comparison with the existing international compliance standards. Calculation of the amount of particulate matter (PM), according to the emission factor of the Danish National Environmental Research Institute[32] for commercial and institutional plants burning biogas: 2. 1.5 g/GJ_{biogas}[32] (PM10 and PM2.5), that equals to 35 mg/m^3_{biogas} considering the calorific value of biogas of 23.3 MJ/m^3 (according to the FECOC, UPME). The yearly amounts of particulate matter produced are available in the Excel file “EMCALI III.H_GHG emission calculation”, worksheet “Other pollutants emissions”. Knowing that: ➢ the volume of the input gas (biogas) is lower than the output gas (exhaust gas) (due to the addition of the air into the combustion process) $V_{input\ gas} < V_{output\ gas};$ ➢ and so is the concentration of this pollutant per $1m^3$ of the input gas in comparison with its concentration in the exhaust gas, therefore, the value of 35 mg_{PM}/m^3 biogas will be lower if expressed in mg_{PM}/m^3 exhaust gas, as the existing international standards below are expressed: - German standard TA Luft 2002: the combustion of biogas (landfill gas) in the internal combustion engine - the limits are not set; - Swiss LRV standard: the combustion of biogas (landfill gas) in the stationary combustion engine – limit of PM10 and PM2.5 - 50 mg/m^3. <u>Conclusion:</u> The reference amount of 35 mg_{PM}/m^3 biogas emitted as a result of the biogas combustion in the internal combustion engine of the electric generator is lower than the existing international compliance standards. 3. The amount of NO_x emitted, according to the emission factor of the Danish National Environmental Research Institute[29] for commercial and institutional plants burning biogas: 28 g/GJ_{biogas}[30] that equals to 652mg/m^3 biogas considering the calorific value of biogas of 23.3 MJ/m^3 (according to the FECOC, UPME – Mining and Energy Planning Unit). The yearly amounts of NO_x produced are available in the Excel file “EMCALI III.H_GHG emission calculation”, worksheet “Other pollutants emissions”. Remembering that the emission factor of 652 mg of NO_x is expressed per $1m^3$ of the input biogas and the international compliance standards are expressed in mg per $1m^3$ of the exhaust gas and knowing that: ➢ the volume of the input gas (biogas) is lower than the output gas (exhaust gas) (due to the addition of the air into the combustion process) $V_{input\ gas} < V_{output\ gas}$ ➢ and so is the concentration of this pollutant per $1m^3$ of the input gas in comparison with its concentration in the exhaust gas, therefore, the value of 652 mg_{NOx}/m^3 biogas will be lower if expressed in mg_{NOx}/m^3 exhaust gas, as are expressed the limits standards below,	

	We compared this value with the existing international standards: - German standard TA Luft 2002: the combustion of biogas (landfill gas) in the internal combustion engine – limit - 500 mg/m^3 - Swiss LRV standard: the combustion of biogas (landfill gas) in the stationary combustion engine – limit - 400 mg/m^3. Nevertheless, the emission factors used for the above presented estimation of the emissions of NO_x as well as PM resulting from biogas combustion in the internal combustion engine of the electric generator are not decisive as the particular physical conditions of biogas combustion in the WWTP-C and the chemical composition of biogas generated in the Plant may vary substantially from the ones of the emission factors applied. The same can be said for the enclosed biogas flares emissions, as the emissions of NO_x and PM were taken from the study of UK Environmental Agency. Therefore, the calculation and reference data (in case of enclosed flares), presented above, was treated as informative and right after the CDM project registration the WWTP-C was considering to conduct the measurements of the air pollutants in field and to decide whether further treatment was needed to reduce the eventual impact of the biogas combustion. Recently, a Colombian Resolution[31] (Ministry of Environment, Housing and Territorial Development), regulating emissions from stationary combustion sources, was issued establishing emission standards for thermoelectric centrals with installed capacity less than 20MW and existent cogeneration plants (Chapter V, art 13 – Table 9) stating admissible emission of NO_x of 300 mg/m^3 at reference conditions 25°C, 760 mmHg and 3% oxygen (the emission standard for SO_x and PM are not established for this source of emissions). According to the Art 103 of the above mentioned Resolution, the installations that so far were not required to have control of the pollutants (such as the WWTP-C) will have to comply with the rules of the present Resolution in 24 months, counted since the date of the entrance of the mentioned norm into force (June 5th, 2008). In line with the above stated, the PATR-C will take necessary steps to comply with the regulation established by the Colombian Ministry of Environment, Housing and Territorial Development.	
Other contaminants (including where relevance applies: toxic, radioactive, COPs, ozone cape damaging gases).	The projects activity does not generate this sort of contaminants neither does avoid nor reduce its generation at WWTP-C.	0
Ground condition (quality and quantity) Biodiversity (conservation of species and inhabitant)	The project's activity does not generate additional solid residue to those produced at the WWTP-C in lack of the project.	0

Biodiversity (conservation of species and inhabitant)	The project's activity does not affect any animal or vegetal species of the surrounding area.	0
Sub total		**-1**
Social and development sustainability		
Employment (including work quality, scope and labor Standard achievements.	Labor conditions of the WWTP-C staff will not be modified due to the project's activity. Non to mention these are in conformity with the Colombian labor regulation in force.	0
Assistance to people in poverty conditions (including poverty relief, sense of balance, and additional opportunities for unfavorable sectors, access to essential utilities and power supply access).	The project's activity will be a factor of creating opportunities for young people from low social sectors in school age to access to school to continue studying. On the other hand, working opportunities for adult people from low social sectors will be strengthened through the support and replication of recycling projects at the communities located nearby the WWTP.	+2
Human and institutional capability (including empowering, education, gender equilibrium).	For the implementation of sustainable project performance, as mentioned in section A.2, the Sustainable Development Committee will be created and will be comprised by representative people from the communities nearby and from the WWTP-C, contributing to improve the communities' access to the decision making process for the social project execution on their benefit. Alternatively, by means of the support to schools or education centers located in the area, and donations of education supplies and granting scholarships to young people in school-attendance age from low social sectors, proper media to access to qualified education will be created.	+2
Sub total		**+4**
Economic and technology development		
Employment (number)	At the beginning of the operation and project start up, new job positions will not be created. Officials and contractors from the WWTP-C will assume responsibilities related to those activities.	0
Payment balance (sustainability)	The project's activities do not introduce variances into the payment balance.	0
Technology self-sufficiency (including project replication, hard economic limitations, skill improvement, institutional capability, technology transfer).	The project start-up activity required the foreign experts' support; however, the project operation will be exclusively performed by Colombian staff, working for the WWTP-C, based on the training provided for this purpose. The above allows observing the consolidation of the technology transfer process.	+2
Sub total		+2
TOTAL		**+5**

Project participants do not consider that the activity of the presented CDM project generates significant direct neither trans-boundary negative environmental impacts.

D.2. Environmental impact assessment

Not applicable.

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

The project's activity will be carried out within the Cañaveralejo Wastewater Treatment Plant facilities, located at the north east of Cali, in the Valle del Cauca Department, in the neighborhood of Petecuy I, in the Commune 6 of Cali. Local intended users are in connection with the Communes 6 and 7 of Cali, identified prior the construction of the WWTP-C, in order to begin a permanent and organized approximation towards the local inhabitants and answer their inquiries regarding the possible negative environmental impact on their communities. For such purpose, EMACALI prepared a Social Management Program.

For consulting local intended users about the EMCALI CDM project activity implementation, the most representative leaders from the community were called on May 28, 2007. Among those community leaders such as the Directors of the Integrated Local Assistance Administrative Boards (C.A.L.I. per its initials in Spanish) from the Communes 6 and 7, as well as 20 Local Administrative Boards (JAL per its initials in Spanish)[viii] from the neighbors of the WWTP-C; environmental groups (Environmental Committee from the Commune 7; Guardians of the Channel from the Commune 6) and Social Support (Franciscan priest leader of the gangsters groups peace process) were invited. The invitation was also extended to institutions, such as: DAGMA (environmental authority of Cali), Climate Change Mitigation Group from the Ministry of Environment, Housing and Territorial Development, and the Carvajal Foundation.

The meeting was held at the WWTP facilities with the agenda described below and a Power Point presentation, followed by a question and comment section:

- Sensibility lecture regarding the greenhouse phenomena, global consequences, Colombian vulnerability to climate change, and commitment before the Kyoto Protocol.
- Clean Development Mechanism (CDM) objectives and phases.
- Presentation of the CDM project at the WWTP-C.
- Presentation of both, global and local benefits of the Project activity.
- Answer to inquiries and reception of comments to the Project.

Invitation letters were sent to representative leaders of the communities and institutions, and their attendance was confirmed by phone. The guests and attendance list was as follows:

Table 4. List of guests invited to the meeting with local stakeholders

VISITORS		
COMMUNITIES IN THE VECINITY OF THE WWTP-C	**YES**	**NO**
Aldemar Morales Park Improvement Project -Proyecto Mejoramiento Parque Commune 7	X	
Carlos Mallorquin Commune 6		X
José Ignacio Delgado Commune 6		X
Juan Carlos Vargas Commune 7	X	
Beatriz Salinas Commune 6	X	
Jorge Gómez Commune 6	X	
Frayle Edison Huerfano Commune 6	X	
Orlando Londoño Commune 7	X	
María Luisa López Commune 6	X	
Nelly Salinas Commune 6	X	
Jaime Miranda Commune 6	X	
WWTP-C	**YES**	**NO**
José A. Cerón Director of EMCALI Wastewater Department	X	
Roberto Pomar Director del EMCALI Treatment Department	X	
Olga Guinald EMCALI Communication Office	X	
INSTITUTIONS	**YES**	**NO**
Roberto Esmeral Ministry of Environment, Housing and Territorial Development		X
Inés Fernanda Caicedo DAGMA Director		X
Gustavo Rojas DAGMA Hazardous Waste Coordinator		X
Oscar Rojas Noguera DAGMA Macro processes, Projection and Conservation Coordinator		X
Juan Pablo Bedoya Carvajal Foundation		X

Additionally, PricewaterhouseCoopers provided support to EMCALI with the technical component for the meeting.

The meeting had the participation of the Top Management of EMCALI, such as the EMCALI Wastewater Director (José Cerón) and the Treatment Department Director (Roberto Pomar).

It is important to emphasize that the letters with decisions of the meeting in question were sent to the stakeholders that were invited but did not participate in the meeting and **no comment with respect to the CDM project planning or its operation either comments regarding the decisions of the meeting** were received from them.

Some pictures from the meeting held on May 28, 2007 are presented below. The meeting was complemented with the visit to the WWTP-C installations.

Picture 2: Presentation of the project to its beneficiaries and local communities

Picture 3: Field visit to the WWTP-C project activity to the stakeholders

Picture 4: Presentation of CDM proposed project

E.2. Summary of comments received

Comments received from the meeting held on May 28, 2007, are summarized in the following chart:

Table 5. Comments received on the project activity from the local stakeholders

NAME/ ORGANIZATION	QUESTIONS / INQUIRES / COMMENTS	ANSWERS / EXPLANATIONS
Jaime Miranda/ Commune 6	Expressed that during long time in Cali, the atmosphere had been damaged due to the cane burning, and none of the environmental entities, even DAGMA, has acted to solve this situation.	Regardless it was a comment other than the scope of the Project scope presented and the social purpose of WWTP-C and EMCALI, it was explained that a damaging activity for the environment, such as cane burning, is feasible to be modified by means of the appropriate use of such remain as a power source, and the constitution of a CDM project to reduce the greenhouse gas emission.
Juan Carlos Vargas / Commune 7	Asked if in Colombia there are other CDM projects and how the WWTP-C project has been received at the Ministry of Environment, Housing and Territorial Development.	The answer indicated that at present date, Colombia owns 6 projects recorded before the Kyoto Protocol Executive Board, and the WWTP-C Project was granted with the Non-objection status from the Ministry of

		Environment, Housing and Territorial Development, which is the prior step to obtain the approval for the project.
Jaime Miranda / Commune 6	Commented that dumps generate gas emissions, and asked why not to take advantage from the power source of dumps, such as the Jamundi city example, where there is a dump currently using the methane gas produced there.	Regardless it was a comment other than the scope of the Project scope presented and the social purpose of WWTP-C and EMCALI, it was explained that, it was expressed that the EMSIRVA Manager (company responsible for the management of the dump of Cali) is concerned about studying the possibilities of the clean development mechanism to make feasible such advantage; on the other hand, it is clear that the new dump location to assign for disposal management shall consider this alternative. It also was remarked the need to start acting and become ourselves in seeds to germinate a culture change towards this matter.
Juan Carlos Vargas / Commune 7	Congratulated the project presentation and encouraged to continue with it.	-

E.3. Consideration of comments received

Clarifying explanations were provided to the meeting attendants with regard to the matters expressed in the comments and inquiries received. There were no negative comments or worries about the project that may require a decision taking action plan from EMCALI for the project planning or operation stages.

SECTION F. Approval and authorization

Date	Issue description
8th of June, 2001	Earliest CDM consideration evidenced in the internal communication of EMCALI.[13]
28th of June, 2001	Further details on the consideration of the project as CDM, evidenced in the internal communication of EMCALI.
31st of March, 2002	Project starting date evidenced through the communication from Mitsubishi Project Development Department
2nd of July, 2003	Project viability consultation of EMCALI to the Ministry of Environment, Housing and Territorial Development [16]
29th of October, 2004	Minutes of the Meeting between EMCALI and the Contract Consortium, related to the finalization of the sludge treatment plant contract and some pending items (capture and combustion). [17]
25th of October, 2005	Communication between EMCALI Director of Residual Waters and Climate Change Manager of PricewaterhouseCoopers inviting the company (PwC) to present a proposal for CDM project development. [18]
6th of June, 2006	Agreement between PwC and EMCALI for the development of the project as CDM. [19]

15th of September, 2006	Evidences of the barriers to the implementation of the project activity [20]
9th of January, 2007	Non Objection Letter of the Ministry of Environment, Housing and Territorial Development of Colombia (Colombian DNA) granted to the project. [21]
29th of April, 2008	Project Letter of Approval received from the Ministry of Environment, Housing and Territorial Development of Colombia (Colombian DOE). [22]
20th of May, 2008	Clarification of the Letter of Approval granted to the project. [23]

Appendix 1. Contact information of project participants

Organization name	**EMPRESAS MUNICIPALES DE CALI, EMCALI, EICE ESP** *(Empresas Municipales de Cali EMCALI, EICE ESP)*
Country	Republic of Colombia
Address	Cll 73A #2E-97 Barrio Petecuy, Valle del Cauca, Cali
Telephone	57-2-8996400
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E-mail	gisepulveda@emcali.com.co
Website	
Contact person	Gilberto Sepulveda. Chief of Treatment Department EMCALI

Appendix 2. Affirmation regarding public funding

No public funding was involved in financing of the proposed project activity

Appendix 3. Applicability of methodologies and standardized baselines

Table 3: - Goal of the decontamination - The flow and charges of influent wastewater entering the WWTP-C due to new inversions

Cuadro 7.17 – Meta de Descontaminación – Caudales y cargas por nuevas inversiones mas afluente PTAR-C

PLANTAS DE TRATAMIENTO	PTAR-C (1)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
PTAR - CAÑAVERALEJO											
Remoción DBO 33% SST 56%											
CARGAS AFLUENTE											
DBO - Kg/d	69.868	87.247	89.707	90.449	91.479	92.107	94.635	95.283	95.736	95.801	96.466
SST - Kg/d	53.688	69.030	71.390	71.995	72.831	73.377	76.468	77.263	77.819	77.899	78.377
CAUDAL - l/s	3.810	5.642	5.952	6.022	6.119	6.186	6.576	6.676	6.746	6.756	6.786
CARGAS REMOVIDAS											
DBO - Kg/d		28.791	29.603	29.848	30.188	30.395	31.229	31.443	31.593	31.614	31.834
SST - Kg/d		38.657	39.978	40.317	40.785	41.091	42.822	43.267	43.579	43.623	43.891

Table 4: Average percentage of dry matter in untreated sludge 2006 & 2007

Year 2006	JAN		FEB		MAR		ABR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC	
SEDIM TANKS	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
1	0.30	0.33	0.38	0.76	0.65	1.95											0.42	1.05	0.84	1.14	0.92	1.37	0.83	3.56
2					0.55	1.07	0.27	0.43							0.62	0.76	0.33	0.92	0.54	0.73	0.83	1.96	0.96	2.00
3							0.34	0.68	0.28	1.48	1.09	1.21	0.39	1.11	0.64	0.85	0.43	0.90	0.87	0.93	0.77	2.11	0.98	2.28
4			0.80	1.13	0.92	1.22	0.47	0.89	0.60	1.26	0.98	1.47	0.34	0.73	1.46	0.98								
5	0.89	1.56	0.83	1.74	1.10	2.27	0.40	0.85	0.38	2.08	1.00	2.48	0.33	1.38	0.74	1.27	0.34	1.10	0.30	0.70	0.69	1.09	1.30	1.16
6	0.71	1.47	0.97	0.77	0.75	2.86																		
7	1.09	1.54	0.50	2.43	0.99	3.07	0.59	1.01	0.48	2.09	1.50	3.30	0.45	0.94	0.95	1.46	0.73	0.60			0.75	1.12	1.15	2.10
Total average	1.066																							

Year 2007	JAN		FEB		MAR		ABR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC	
SEDIM TANKS	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
1	0.42	0.57	0.38	1.29	0.73	2.13			0.53	1.43	0.58	1.38	0.48	1.43	0.88	1.77	0.41	1.98	0.80	1.35	1.15	2.32	1.06	2.19
2	0.78	1.61	0.34	1.88	1.25	2.27	0.88	1.07	0.41	1.26	1.17	1.15												
3	0.80	1.99	0.46	1.86	0.79	1.74	0.90	1.16	1.38	0.66														
4							1.60	0.98	0.93	1.26	1.27	1.32	0.83	1.62	0.78	1.20	0.47	1.74	0.69	1.56	0.94	2.27	1.16	2.98
5	0.84	1.76	0.57	1.64	1.26	2.38	0.74	1.26	0.59	1.56	0.98	1.63	1.03	1.70	1.27	2.34	0.71	2.64	0.97	1.92	1.17	3.83	2.09	4.60
6																								
7	1.02	1.51	0.46	1.92	1.35	2.40	0.66	1.00	0.62	1.67	0.87	1.44	1.06	1.31	0.60	1.67	0.37	1.99	0.75	2.21	1.66	3.04	1.96	3.56
Total average	1.357																							

Average dry matter of two years 2006 & 2007	1.21

Appendix 4. Further background information on ex ante calculation of emission reductions

Not applicable.

Appendix 5. Further background information on monitoring plan

Not applicable.

Appendix 6. Summary report of comments received from local stakeholders

Not applicable.

Appendix 7. Summary of post-registration changes

The PRC-2341-001 (approved on 01/07/2015) included the following changes:

- Parameters removed of the monitoring plan:

    - $T_{,H,h}$: Temperature of biogas fed into the water heater (°C)

      $T_{G,h}$: Temperature of biogas fed into the engines of the electric . generators (°C).

    - $T_{G,h}$: Temperature of biogas flared (°C)

    - $P_{,G,h}$: Pressure of biogas fed into the engines of the electric generators (mbar)

    - $P_{H,h}$: Pressure of biogas fed into the water heater (mbar)

    - $P_{,G,h}$: Pressure of biogas flared (mbar)

- Due to the volumetric flow meters deliver results in normal conditions, and these were used for this correction.
- The management and monitoring structure and responsibilities of staff related to CDM project activity of Emcali has been modified taking into account new changes in the organizational structure of the entity.

New post registration of changes included in new version (version 06) of the PDD:

Corrections:

1. New figures (2 and 3) have been included to clarify the technology and boundaries of the project activity.
2. The following sentence: "*basic technical specifications of the biogas flare, water heater, dehumidificator, biogas storage tanks and generator's engine (more information available upon a request)*" has been deleted since it was repetead in Section A.3.
3. Information regarding project participants has been updated in this new version of the PDD to be consistent with the UNFCCC website (inclusion of ALLCOT AG).
4. Section A.7 has been modified to include the use of the Methodological tool: Assessment of debundling for small-scale project activities Version 04.0 instead the Appendix C of the Simplified Modalities and Procedures for Small-Scale CDM Project Activities.
5. Section A.8 has been reinforced including the three applicability conditions of the applied methodology to be consistent with the rest of the document.
6. Project boundaries and sources and gases included and excluded in the calculations have been clarified (Section B.3).
7. Figure 4 has been included to clarify the boundary of the project activity amongst the inclusion of the Biogas alternative use and Energy Consumption of the Grid.
8. Ex post baseline calculations have been clarified in section B.6.1 to be in accordance with paragraph 36 of the applied methodology.
9. The calculation of Project activity emissions from electricity consumption are clarified (in section B.6.1) to be determined as per the procedures described in the latest version of the AMS I.D (Grid connected renewable electricity generation) at the moment of the registration of the project activity (version 13) since the reference to the "Tool to calculate the emission factor of the grid" was not correctly included.
10. A clarification regarding the consideration of Project Emissions has been included in the PDD. Since no new sludge treatment is performed in the project respect to the baseline scenario, i.e, the amount of untreated sludge generated ($_{Sy,untreated}$) is the same than in the baseline scenario, therefore, the potential to generate methane are equal in the baseline and the

proposed project activity. Therefore, $MEP_{y,s,treatment}$ is considered zero in the ex post calculations. It was included in the PDD only for the ex-ante calculations. This consideration was approved by the Validating DOE during the registration of the project, as it is detailed in the Validation report with reference NO. 2008-BQ-ME-15, and therefore, this is considered only a correction in the reporting.

11. Three monitoring parameters have been detailed in the monitoring plan of the revised PDD to be in accordance with the applied methodology. These parameters were monitored in accordance with the methodology, but, they were not correctly reported in the registered PDD.
    - Flare efficiency (%).
    - Grid electricity consumption in year “y” (MWh).
    - Grid emission factor (tCO2/MWh).

    The operating time of the flares and the water heater are calculated using the values of the temperature, and it is clarified in the respective monitoring parameters (T_{flare1}, T_{flare2}). The operation hours of the water heaters are also calculated using the values of Volumetric flow rate of biogas and volumetric fraction of methane fed into the water heater. And a clarification is also included in the monitoring parameter. It is considered as correction since all of them were considered in the calculations stated in the PDD, but, the tables were not correctly included in the registered version. The process of improve the report of them does not affect the baseline, additionality or design of the project, in accordance with appendix of the CDM Project Standard.

END NOTES

1 Resolution 1096 of 2000 which adopts the Technical Regulations for the Sector of Drinking Water and Basic Sanitation, Art. 172

2 Resolution 0453 of 2004 of the Ministry of Environment, Housing and Territorial Development that adopts the principles, requirements and criteria and establishes procedure for the national approval of the projects that reduce he greenhouse gasses emissions and opt for CDM

3 Sustainable Development Strategic Plan Period 2004-2008. Center of Integrated Local Administration, CALI, Community 6 and 7

4 Characterization of biogas reported in May 8th and 15th of 2006 (Biogas sampled in digesters B, C and E). Treatment Department of PTAR-C

5 Technical specifications of gas purifier

6 Sanitation and Wastewater Management Plan 2007-2016. EMCALI

7 Mitsubishi letter on the payments related to the project activity of 10th of June, 2009

8 Internal communication of EMCALI of June 8th, 2001 -official letter no 300700-063-01

9 Internal communication of EMCALI of June 28th, 2001 – official letter no 300700-069-01

10 Internal communication of EMCALI of June 8th, 2001 -official letter no 300700-063-01

11 Viability consultation of EMCALI to the Chief of Colombian Office for the Mitigation of Climate Change of the Ministry of Environment, Housing and Territorial Development of July 2nd, 2003 – official letter no 300000-GAA-1376-03

12 Final liquidation Act of 29th of October, 2004

13 Communication between EMCALI and PricewaterhouseCoopers of 25th of October 2005 – official letter no 330-DAR-354-2005

14 Additional clause no. 1 to jointly develop the environmental derivative benefits of the collection and use of green house gas project generated at the Cañaveralejo Wastewater Treatment Plant, as well as the others currently in the planning and design stage to obtain the certified emission reductions in compliance with the Clean Development Mechanism of the Kyoto Protocol of September 12th, 2006.

15 Communication between Mitsubishi (Mr. Hirotsugu Ishiyama, General Manager) and EMCALI (Lourdes Salamanca, General Manager) of September 15th, 2006 – Ref. no. TOK/MBI-715

16 Non Objection Letter of the Ministry of Environment, Housing and Territorial Development of Colombia of January 9th, 2007 – official letter no 2000-2-125111

17 Letter of Approval of the Ministry of Environment, Housing and Territorial Development of 29th of April, 2008 – official letter no 2000-2-46659

18 Clarification to the Letter of Approval of the Ministry of Environment, Housing and Territorial Development of 20th of May, 2008 – official letter no 2000-2-55811

19 Decree 1220 of 2005 of the Ministry of Environment, Housing and Territorial Development that regulates the Act 99 of 2003 about environmental licenses

20 Resolution 1096 of 2000, Art. 172, which adopts the Technical Regulations for the Sector of Drinking Water and Basic Sanitation Communication between Mitsubishi (Mr. Hirotsugu Ishiyama, General Manager) and EMCALI (Lourdes Salamanca, General Manager) of September 15th, 2006 – Ref. no. TOK/MBI-715

22 Supports of the PTAR-C training sessions by Mitsubishi

23 http://reportes.sui.gov.co/reportes/SUI_ReporteAlcantarillado.htm

24 http://www.minambiente.gov.co/documentos/PROYECTOS%20DE%20CAMBIO%20CLIMATICO%20V.2%20FEBRERO%2029%2008.xls

25 Sanitation and Wastewater Management Plan 2007-2016. EMCALI

26 Operation Executive Reports of the PTAR Cañaveralejo for years 2006 (p. 4) and 2007 (p. 4)

27 Technical specifications of contingent biogas enclosed flare

28 The crediting period is of 10 years and is planned to start in August 1st 2008 or at the moment of the project's registration

29 Guidance for monitoring enclosed landfill gas flares. UK Environmental Agency, September 2004

30 http://www2.dmu.dk/1_Viden/2_miljoeilstand/3_luft/4_adaei/tables/emf_stat_combustion_main_2005.html

31 At 273K, 101.3 kPa and 3% oxygen

32 At 273K, 101.3 kPa and 3% oxygen

33 http://www2.dmu.dk/1_Viden/2_miljoeilstand/3_luft/4_adaei/tables/emf_stat_combustion_main_2005.html

34 All the standards mentioned were consulted in the document "Guidance for monitoring landfill gas engine emissions" of the UK Environment Agency. See the document attached.

35 http://www2.dmu.dk/1_viden/2_Publikationer/3_arbrapporter/rapporter/AR200.pdf

36 http://www2.dmu.dk/1_Viden/2_miljoe-ilstand/3_luft/4_adaei/tables/emf_stat_combustion_main_2005.html

37 http://www2.dmu.dk/1_viden/2_Publikationer/3_arbrapporter/rapporter/AR200.pdf

38 http://www2.dmu.dk/1_Viden/2_miljoe-ilstand/3_luft/4_adaei/tables/emf_stat_combustion_main_2005.html

39 Resolution 0909 of June 5th, 2008, through which admissible emission norms and standards are set for the atmospheric air pollutants from fixed sources and other dispositions are given

40 JAL: Local Administrative Board is the most representative entity at the community level, responsible for the administration of the community location/neighbor in conjunction with the Major's office, in conformity with the Development and Performance plan.

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Document information

Version	*Date*	*Description*
11.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the "CDM project standard for project activities" (CDM-EB93-A04-STAN); • Make editorial improvements.
10.1	28 June 2017	Revision to make editorial improvement.

Version	Date	Description
10.0	7 June 2017	Revision to: • Improve consistency with the “CDM project standard for project activities” and with the PoA-DD and CPA-DD forms; • Make editorial improvement.
09.0	24 May 2017	Revision to: • Ensure consistency with the “CDM project standard for project activities” (CDM-EB93-A04-STAN) (version 01.0); • Incorporate the “Project design document form for small-scale CDM project activities” (CDM-SSC-PDD-FORM); • Make editorial improvement.
08.0	22 July 2016	EB 90, Annex 1 Revision to include provisions related to automatically additional project activities.
07.0	15 April 2016	Revision to ensure consistency with the “Standard: Applicability of sectoral scopes” (CDM-EB88-A04-STAN) (version 01.0).
06.0	9 March 2015	Revision to: • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; • Make editorial improvement.
05.0	25 June 2014	Revision to: • Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1; • Change the reference number from F-CDM-PDD to CDM-PDD-FORM; • Make editorial improvement.
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.
04.0	13 March 2012	Revision required to ensure consistency with the “Guidelines for completing the project design document form for CDM project activities” (EB 66, Annex 8).
03.0	26 July 2006	EB 25, Annex 15
02.0	14 June 2004	EB 14, Annex 06b
01.0	03 August 2002	EB 05, Paragraph 12 Initial adoption.

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